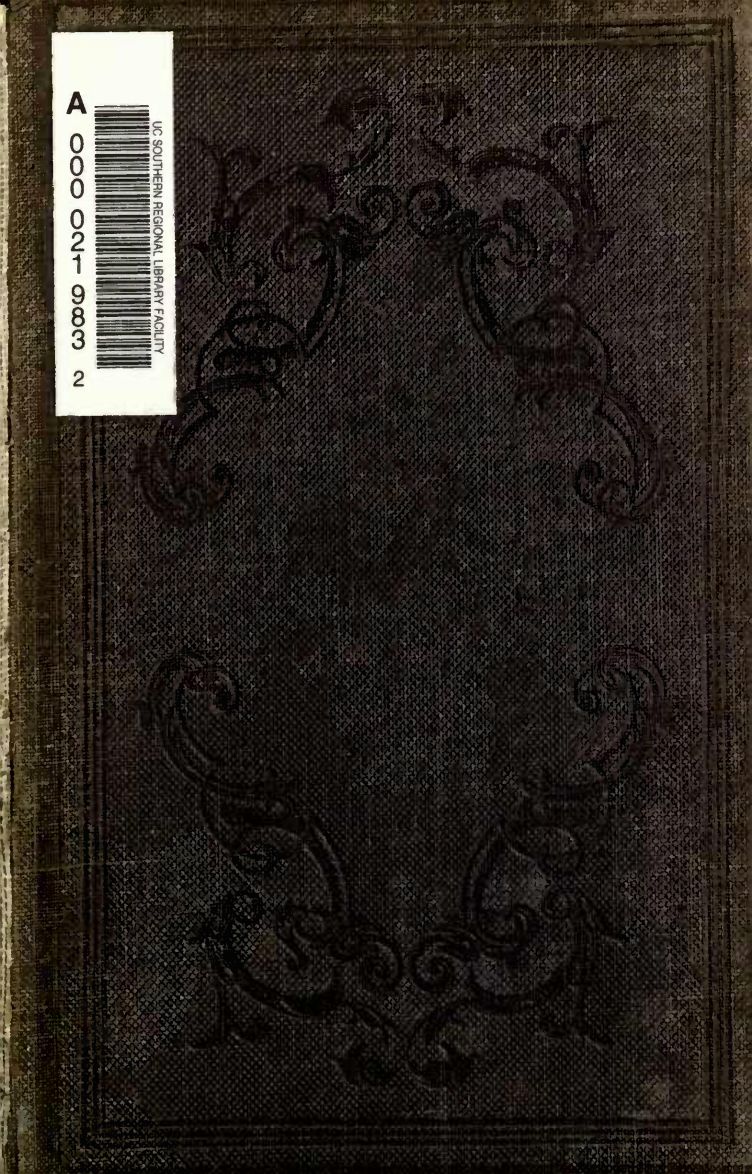
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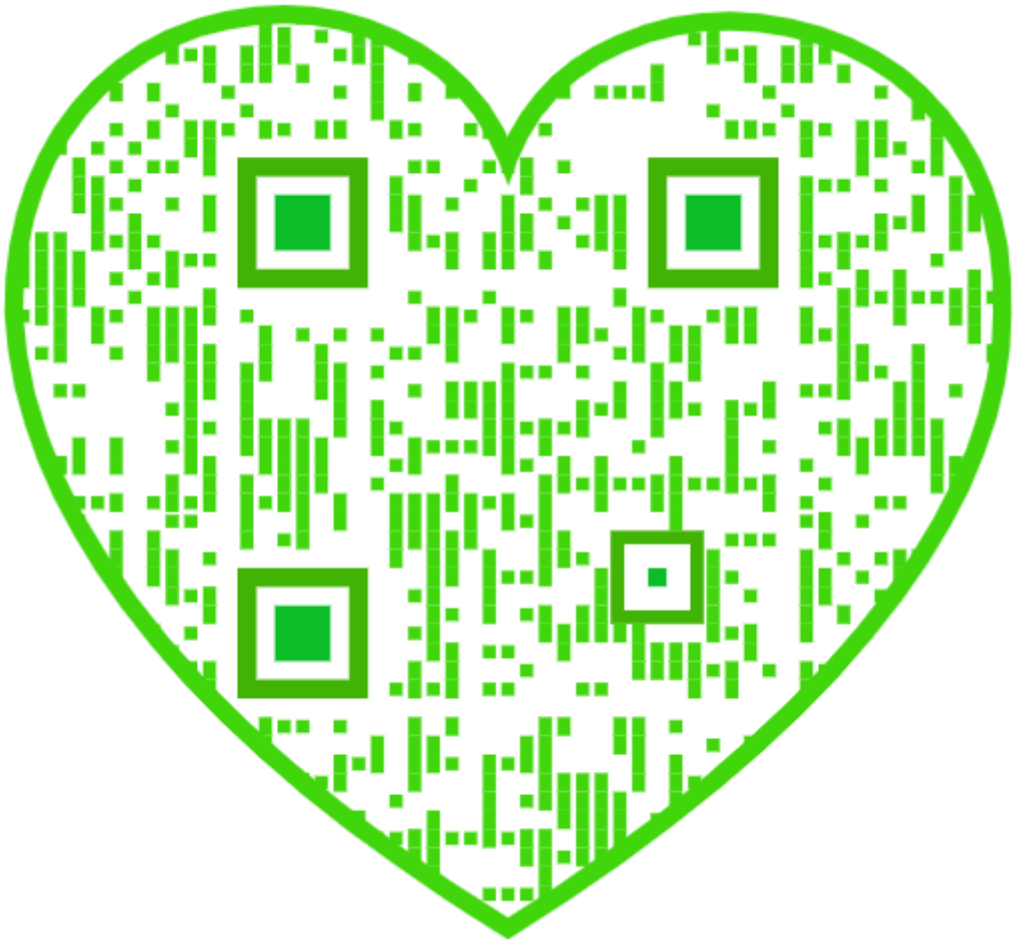

THE

HISTORY

OF

PRINTING.

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HISTORY OF PRINTING.

PRINTING is the art of taking impressions, from characters or figures, on paper, linen, silk, and other fabrics. There are several kinds of printing; from moveable letters, and from metal casts obtained from them, for books; from engravings on wood and metal, for pictures; from blocks, on which birds, flowers, and designs are cut, or from rollers on which they are impressed, for printing calico, linen, paper-hangings, &c.; from letters and drawings sketched upon stone, coated with grease, called lithography; and, finally, the newly-invented art of natural printing, which consists in stamping natural objects, such as leaves, feathers, and flowers, upon sheets or rollers of metal in a softened state, and printing from these rollers on paper. But though the above is the technical definition of printing, a much wider meaning is generally given to the term. "The essence of printing," we are told by an able writer, "is the production

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of a copy by pressure." In this sense, then, to seal a letter is to print upon wax, and to coin or stamp money is to print upon gold, or silver, or copper, or whatever may be the substance used.

The early Egyptians were the earliest printers; for they printed inscriptions on bricks; and some of the stamps which they used for the purpose now form part of the antiquarian treasures of the British Museum. The people of Babylon also rudely practised the art more than two thousand years ago. Bricks are frequently found by persons engaged in excavating and exploring the gigantic ruins of the fallen city, bearing the name of Nebuchadnezzar stamped upon them. The manner in which this was done is known from its simplicity. The inscription, having been engraved on a piece of wood or stone, was stamped on the wet clay; and the brick formed by the clay was either dried in the sun or burnt in a kiln. The bricks were thus rendered so durable, that they have survived the city itself. This may be called clay printing, and probably was the first step in the art.*

The next was the use of the seal for making impressions. The earliest mention of a seal,

* The oldest and most authentic of all books, the Holy Bible, speaks of printing in Leviticus xix. 28: "Ye shall not make any cuttings in your flesh for the dead, nor *print* any marks upon you." This refers to the custom of tattooing. Again, Job says, "Oh that my words were now written, that they were *printed* in a book," xix. 23.

let us premise, is found in the thirty-eighth chapter of Genesis. Three thousand five hundred years ago, Judah, one of the sons of Jacob, we are told, gave his seal or signet in pledge to Tamar. At that time, however, seals were not used to close letters, but instead of them. A seal was an emblem of authority, instead of the proof of the authenticity of a document. The first instance of the use of the seal in closing letters described in Holy Scripture, is in connexion with the wicked deeds of Jezebel, about nine hundred years before the birth of Christ. Ahab, king of Samaria, coveted the vineyard of Naboth, in Jezreel, desiring to make a herb garden of it, because it was near to his palace. Naboth refused to part with the vineyard, either for its worth in money or in exchange for a better one, because it was the inheritance which had descended to him from his father. Ahab was so mortified with disappointment, that he lay down upon his bed, turned away his face, and would not eat. Jezebel, his wife, asked him why he was so sad, and he con-

The meaning of Job is clear from the words which follow:—"That they were graven with an iron pen and lead in the rock for ever." He wished that they might be registered in a book of record, and inscribed on a rock or pillar, according to the custom of ancient times. The translator has used the modern word "printed" to convey an ancient meaning; and it is calculated to deceive. Printers sometimes quote the words of Job in proof of the high antiquity of the art; it is obvious he meant something very different from modern printing.

fessed what troubled him. Jezebel thereupon bade him arise and rejoice, promising to give him the vineyard. "So she wrote letters in Ahab's name, and sealed them with his seal, and sent the letters unto the elders and to the nobles in his city, dwelling with Naboth."* The elders and nobles, at Jezebel's instigation, falsely accused Naboth of blaspheming God and the king; and he was stoned to death. For this act of oppression and bloodshed, God sent Elijah to meet Ahab, when he went, having killed Naboth, to take possession, and the prophet foretold the coming punishment of the guilty king and queen: "In the place where dogs licked the blood of Naboth shall dogs lick thy blood, even thine;" and again "the dogs shall eat Jezebel by the wall of Jezreel." The prophecy, we need scarcely add, was strictly fulfilled, and where Ahab sought only his pleasure, he found death, and Jezebel a dishonorable grave.

The Romans used seals at a very early period of their history. It is clear, moreover, from some Roman seals which are still in existence, that the crude principle of letter-press printing was known to them. They certainly practised that rude and cruel form of printing which is not yet banished from our fields, the branding of cattle with red-hot irons, which after all is printing in hair, wool, and hide. It is not known what substances the Romans used as sealing-wax; and

* 1 Kings xxi. 8.

the knowledge of it having been lost by succeeding nations, they substituted lead. The earliest seals in Christian times were thin impressions upon lead. The Emperor Charlemagne wore his seal on the pommel of his sword, and he used to say, "I will maintain with the point that which I have engaged (*i e.*, set his seal to) with the hilt."

The invention of money was another step in the art of printing. To stamp the figure of a head or any other device, on a piece of money, is nothing else than to print on a piece of metal. Remarkably enough, too, the method used in stamping money is the same now as it has ever been. An engraving of the device to be stamped, or die, as it is called, is cut on a punch, or handle, and the punch is forcibly driven against the metal, which is thereby stamped with the device. It is uncertain when money was first coined. No mention of money is made in the early part of Holy Scripture,* and the earliest profane writer, Homer, says nothing whatever on the subject.

* We read of *shekels* as early as the time of Abraham. For instance, Abraham gave 400 skekels of silver "current money with the merchants," as the Scripture says, for a burial-place for Sarah his wife, and she died about 1860 years before the birth of Christ. But though the word "money," is used in the translations of the Bible, it is not found in the original Hebrew; for what is now commonly called money did not exist amongst the Jews. Skekels were weights not coins, and consisted of ingots and wedges of metal. The word "coin," it is supposed, is derived from the Latin word for wedge. At a later period the Jews stamped their skekels with Aaron's rod

Though commerce sprung up at a very early age, it was for a long time carried on by barter. Herodotus, surnamed "the Father of History," says that the Lydians were the first people who coined gold and silver money. The origin of it is also attributed to Pheidon, king of Argos, 895 years before the birth of Christ. The Hindoos used to possess a coin which they declared to be 4000 years old, and they reverenced it like a god. It was originally dug up near the royal palace of Mysore. It was afterwards found amongst the treasures of Tippoo Saib, captured by the British army at Seringapatam, and is now in the possession of the East India Company. Its age is, in all probability, fabulous.

As seals were formed with a graver, and money with a die, it is obvious, that engraving preceded the primitive method of printing. Some particulars of the early history of this art may therefore not be out of place. The ancient Egyptians, who were, perhaps, the people first formed into a nation, were great and very expert engravers. The stone coffins, or sarcophagi, in which they buried their dead, the walls and pillars of the vast temples in which they worshipped their strange gods, their statues and obelisks, the Egyptians covered with figures and inscriptions, and even

and the golden pot that held the manna; just as in our time pure gold and silver articles are stamped with the mark of the Goldsmiths' Company, as a proof of their purity.

pictures of battles, processions and other events, engraved with a superiority of style, which is the wonder of our more enlightened age. The engravers of the present day are, in fact, inferior in one respect to those who lived three thousand years ago. We possess no tools hard enough or sharp enough to cut the granite and porphyry and jasper, which the Egyptians covered with the most exquisite engravings. We can only guess at the means by which these works were accomplished.

We are told in the Book of Exodus, that the children of Israel, during their bondage in Egypt, learnt the art of engraving on seals and on metal plates, from their oppressors. When they were delivered from captivity, Moses was commanded by the Lord, "to make a plate of pure gold, and grave upon it like the engravings of a signet." Bezaleel is also mentioned as being "filled with the wisdom of heart, to work all manner of work with the graver, as well as to devise cunning works, to work in gold, in silver, and in brass." The earliest Greeks used engraving in delineating maps on metal plates. Aristagoras, we are told by Herodotus, appeared before the king of Sparta, five hundred years before the birth of Christ, with a tablet of brass, on which were inscribed every part of the habitable world, the seas, and the rivers. Probably as early as this, at all events before the time of Christianity, lands were granted in the penin-

sula of Hindostan by deeds engraved on copper, just as we now engross them on parchment. One of these copper plates, or deeds, bearing date twenty years before the birth of Christ, is still in existence. Engraving, however, is not printing, though one might have naturally suggested the other. Yet strangely enough, letter-press printing, that is, the art now commonly used, was discovered before any one had obtained impressions from engraved plates. The art of printing pictures and writing, by the means of engraved copper plates, dates from and after the time of letter-press printing.

The first appearance of printing in a practical shape, was when the seal, or other stamp, instead of being forced against a softer substance than itself, was wetted with some liquid of the nature of ink, and pressed upon another body, so that an image or picture of the stamp was transferred to that other body. This was first accomplished in China, by a minister of state named Foong-taon, in the tenth century. Foong-taon was a learned man, as all the great officers of state in China must be, learning being the only road to royal favour in that country. He desired to multiply the copies of a book which had pleased him, and at the same time save the labour of writing them. This task had until then been deemed impossible; but probably the thought struck Foong-taon that with some contrivance he

might multiply writing in the same way that he could multiply the impressions of a seal. The idea was simple and natural, and the only difficulty in the way was how to make a stamp like the writing to be multiplied. A little observation soon instructed him. He placed a page of writing, while it was wet, upon the face of a smooth piece of wood. The writing made a mark on the wood, just as a letter does when it is turned down upon a sheet of blotting-paper. A copy of the writing was, in other words, impressed on or transferred to the wood. Then all that part of the surface of the wood not touched by the writing,—that part between and around the strokes of the characters,—was cut away with a chisel or graver, so that the wood was converted into an engraved tablet; with the difference that in an engraving, the letters are cut *into* the face of the material, like the inscription on a tombstone; while in this kind of printing, the face itself was cut away, leaving the letters standing out, like the raised letters we see on a shop front. The letters thus formed by Foong-taon were wetted with some kind of ink, paper was then pressed upon them, and an inken copy of the letters was thereby transferred to the paper. This was really and truly the art of printing.

The Chinese are remarkable for their stationary character. They are nearly the same to-day as they were a thousand years ago, and a thousand years ago as they were thousands before. They were the inventors of gunpowder,

but they have made no use of it because their fathers did not. As they built houses and temples, and made silk and porcelain ten centuries since, so they do now, neither better nor worse; neither their music nor painting, nor any other art, has undergone any change during the course of time. They have, in a word, buried their talents in a napkin. Printing has fared no better than the other arts in China. To this day the Chinese print in the same manner as they did nine hundred years ago; or, according to their own reckoning, nineteen hundred years ago. A wooden block or plate of wood, generally cut from the apple or pear tree, is shaped to the size of the page of the book which it is proposed to print. The surface of the block is then rubbed with paste, made sometimes from boiled rice, and it is thus rendered very smooth. The words which each page is to contain, are finely written on soft transparent paper, and while the ink is still wet, the paper is laid on the surface of the block, the side written on being downwards, so that the writing appears in an inverted order through the thin paper on which it is written. The paper is then gently rubbed on the back, and a clear copy of the writing remains on the surface of the wood. The wood is then cut away as already described, and a wooden copy of the writing is left. The printing is done without a press; for so delicate is the paper of which the Chinese

books are formed, that it would be broken by any heavy pressure. A little friction, indeed, is sufficient to give the required impression. The printer holds in his right hand two brushes, or rather a handle with a brush at each end of it; with one of these brushes he lays the ink on the letters; then having laid the paper on the inked letters, with the other brush he gently rubs the back of the paper. This effects the printing; and so expert are the workmen, that even in this rude way, one man can print two thousand copies in a day.

It is a striking circumstance, certainly, that the Chinese who were the first inventors of printing have been the last to improve the art. But though national character has much to do with the matter, it is not the sole cause of it. The fact is not so unnatural as it may seem, when all circumstances are considered. It is partly owing to the nature of the Chinese written language. The English written language consists of twenty-six letters, each having a particular sound attached to it, and by changing the position of these letters, we can form all our words, and express all our thoughts. Nor is there any practical limit to the power of expression which these twenty-six letters possess, since they may be formed into no less than 620,448,401,733,239,439,360,000 different combinations or words without a single repetition. The Chinese written language is not, however, expressed by different

combinations of a few simple letters, but consists of a separate character for every separate word. Chinese characters are, in fact, signs of words, formed without the use of letters. The language may be described either as all alphabet and no words, or as all words and no alphabet; and, in consequence, a person must learn, some say 5,000, others say as many as 60,000 characters, before he can read a Chinese book with ease. The use of moveable types, which constitutes the great improvement in printing, the Chinese generally consider more tedious than printing in blocks as we have described. The time occupied in cutting or casting the number of separate characters required to print a book in the Chinese language, it was long held by other nations would actually be greater than the time in which it might be written. But the principles of the language having been intimately studied, it has been found practicable to print the Chinese characters by a combination of moveable types. One mode, the invention of Legrand, of Paris, consists in adding to the character representing the key, another character which alters the sense. The number of punches used, that is, the number of different types required, is 4,600, and this is the mode most simple and most generally used. Another mode, invented in Austria, consists of a number of points and strokes, which are put together in the form of the Chinese words.

For three hundred years the Chinese practised the art unknown to the western nations which boasted of greater progress in arts and civilization. China itself was unknown to the rest of the world, except by name. But the veil which had so long concealed one of the most wonderful nations of the world, was removed in the thirteenth century by the enterprising traveller Marco Polo. In the year 1250, two brothers named Polo, who were merchants at Venice, sailed up the Black Sea on a trading voyage. Drawn farther and farther by the allurements of profit, mingled with a love of enterprise, they reached Bokhara, the capital of the kingdom of the same name, situated in the centre of Asia. Though they were strangers, the inhabitants treated them well, and they remained three years at Bokhara studying the Mongol language. In 1264 an ambassador from Hulako, the grandson of Gengis, king of Persia, passed through Bokhara on his way to the court of Kublai, a great khan of the Mongols, who at that time ruled over Tartary and China. The adventurous Venetians, accepting an invitation from the Persian ambassador, accompanied him to Kemenfu, which they reached after a year's journey. Kublai received them kindly, and listened with wonder and admiration to their description of the unknown nations from which they had come. A European was as great a curiosity to him as a Japanese still is to us. Eventually he made the brothers his

envoys to the Pope of Rome, who was then, perhaps, the most powerful sovereign of Christendom. On setting out to return to Europe, Kublai charged them with a letter to the Pope, requesting him to send a hundred learned men to instruct the Tartars in the wonderful arts and sciences of the West. The brothers reached Venice in the year 1269, after an absence of nineteen years. They had long been mourned as dead, and the wife of the elder brother Niccolo, had died, after giving birth to a son, who was now approaching manhood. The narrative of their strange travels appeared to those who heard it like a story of another world. The brothers, however, set soberly about the discharge of their duties as envoys from a barbarous to a Christian court. They applied to Rome for a body of learned missionaries; but the death of Pope Clement IV., and the delay in the election of his successor, interposed great obstacles. The two Polos thereupon determined to return to Tartary, taking only young Marco with them; but just before setting out, Gregory X. appointed two Dominican friars to accompany them. The party had not advanced far into the interior of Asia, before the friars became frightened by the rumours of war which reached them, and turned back. The Polos advanced alone, and arrived at Kemenfu in 1275. Kublai, being much pleased with young Marco, sent him on missions to various parts of China and India. He was the first

European that set foot in China Proper; and he traversed it from end to end. Nor did he waste the opportunity of acquiring knowledge, but eagerly collected information about the strange things he saw, or of which he heard. Years afterwards, when he had returned to Europe, he used to relate his adventures in the so-called "flowery land." Those who heard him, however, believed that he was dealing in fiction. Because they could not understand the existence of such things as those he described, they pronounced him a liar. Amongst those things was printing. Marco had seen paper money stamped with a seal coloured with vermilion, and he ranked it as one of the wonders of China.

About the time that Marco Polo related his travels, the simplest form of printing began to be practised in Europe. Printing with wood engravings was effected in 1285 by the two Cunios, relatives of Pope Honorius IV., who resided in some part of Italy, bordering on the Gulf of Venice. Playing cards, invented to amuse the mad king Charles VI., were also printed from blocks about 1350, in precisely the same manner as the Chinese print, that is, with a brush; and this fact raises the presumption that the art was transplanted from China to Europe through Marco Polo's description of it.* Even cards furnish proof that "there is good

* The manufacturers continued until very lately to follow the same process, with this difference, that they used a list instead of a brush to procure the impression.

in everything;" for "the use of cards," as Ottley says, "although it does not appear to have given rise to the art of printing, powerfully operated towards its further promulgation; and it is on that account in a considerable degree connected with its early history." Next, little books were printed with blocks in the same manner as cards, and some of them are still in existence. They were of two sorts —"Books of Images with texts," and "Books of Images without texts." One of these, printed in the year 1423, if the date it bears may be trusted, is now in the Spenser Collection. Another of them, called *Biblia Pauperum*, printed between the years 1430 and 1450, seems to have been regarded as a wonder in its day; for though it contains only forty leaves, yet even such a little book was considered a great one four hundred years ago. It was a kind of catechism of the Bible, each leaf containing a wood-cut with extracts from the Scripture descriptive of the subject. The book was intended for the instruction of children and common people, and hence its title *Biblia Pauperum*, the Bible of the Poor. But in one sense this was a misnomer, however correct in another; for he who has the Scriptures possesses the richest treasure under heaven. In another sense, too, it was a misnomer; for these Bibles, mean as they would seem now, cost more money than the poor in those days could afford to give for them. That these Bibles were highly valued is clear from the

fact that very few of them are in existence; whilst those few are much injured by frequent use. When the Bible of the Poor was printed, a written copy of the Scriptures was worth 100*l*., an enormous sum in those days. Yet by a strange change of circumstances one of these printed Bibles was sold in 1813 to the Duke of Marlborough for no less a sum than 257*l*.

The introduction of moveable types forms a great stride in the progress of the art of printing. This improvement naturally grew out of block printing: yet it was effected somewhat circuitously, if, indeed, it was not entirely the result of accident. From the time of the Romans, poets, lovers, and all others have been fond of cutting the names of their favorites, and their own, upon the bark of trees, just as Niebuhr, the great historian, has painted his name on the walls of Persepolis, and just as more obscure persons scratch their names on the pyramids of Egypt, to inform the world they have been there. This trick of personal vanity we may mention, has been carried to such an outrageous length by the admirers of Gustavus Adolphus, the "Lion of the Protestant faith, and the bulwark of the North," that to prevent the total destruction of the monument erected where he fell on the battle-field of Lutzen, the authorities have set up a post close by, and an inscription, requesting all persons desirous of recording their visit to cut the post, and not the monument. From a

cause so remote it would seem has resulted an effect so glorious as the greatest improvement in the art of printing. The story was passed down for 150 years, as a lighted torch passes from hand to hand without being extinguished, until it was committed to the safe keeping of paper and print; and thus it runs:—

The city of Haarlem, in the north of Holland, was a flourishing place even as early as the twelfth century. The streets were adorned with groves of trees by the liberal public spirit of its rich merchants, and for these, as well as for the culture of flowers, it has been long famous. There was a time when as much as 10,000 florins were given for a single tulip grown at Haarlem, and even now 100 florins are often paid for a single root of the hyacinth, a flower with which the city still supplies the remotest corners of Europe. Amongst the inhabitants of Haarlem in the year 1424, was one Laurence Zanssen. He was church-warden, treasurer, and sexton of the parish church of St. Bavon, as many of his ancestors had been before him: and for that reason assumed the surname of Coster, that is, sexton. The office was one of much respectability and profit, and Coster, as we shall call him, was greatly esteemed by his fellow-citizens. He lived in a large and fashionable house opposite the royal palace. It is now the Town Hall, and owing to its association with Coster's name, it is one of the show places of the city. Coster, like other wealthy citizens who had

leisure, used to walk in the groves which adorned the neighbourhood. But he carried his home feelings with him into the quiet and solitude of the country. A troop of little grandchildren was growing up round the old man's knees, and he found pleasure in thinking how he might amuse them. For this purpose one day he formed some of the letters of the alphabet with the bark of the beech tree. Then he daubed them with some kind of colour, and stamped the letters on paper in the manner of a seal. The letters on the paper were, of course, reversed thus, ⅁. Coster, therefore, cut out letters in a reversed position, so that the impression came right on the paper. Whilst thus engaged in sport, the thought struck him that the process might be turned to a useful account. The connexion was natural in a reflective mind which builds thought upon thought. He saw that if he could print the letters of his grandchildren's names, he could print the letters of books; just as the Marquis of Worcester reasoned, that if steam would lift the cover of a kettle, in greater quantity it would lift a greater weight. Coster's son-in-law, Thomas Peter, agreed with him, and both were men of genius and reflection. The result of their deliberations and experiments was the formation of moveable wooden types. Having found that the common ink made blots, owing to its thinness, they made ink which was thicker. At length they determined to print

a book, and with infinite trouble, as we may reasonably suppose, they succeeded. Their first production contained the letters of the alphabet, the Lord's Prayer, the Creed of the Apostles, and three short prayers. A copy of this book is still in existence, and it is considered that it was completed about the year 1439. It is printed on parchment, on one side only, and the leaves are pasted together in order that the eye might not be offended by the naked sides. The types are rude, the lines uneven, the pages differ in size, nor are they numbered; the words, whenever a part of one is turned into a following line, are divided incorrectly; there are no points, and there are other marks that the book is the work of men who had their trade to learn. When compared with books that were printed soon afterwards, it is at once seen that this was a first attempt.

It may be mentioned here that at a later period, Coster finding that letters of wood were not hard enough to resist the pressure used in printing, made them of lead, and afterwards of pewter. These metal types when worn out, were converted into drinking-cups which were preserved in Coster's family house as late as the time when it was occupied by his great-grandson, Gerard Thomas, who lived to an advanced age.

Everybody understood the advantage of the art when Coster had practised it, just as the Spanish courtiers were able to make an egg

stand on its end when Columbus, breaking the shell, had shown the way. Books were produced with marvellous ease and cheapness; admiration of the art grew, as books were disseminated; and the specimens stimulated the sale. To supply the demand, and reap the harvest of the invention, Coster found it necessary to increase the number of his workmen. These, in return for being taught the new art, were solemnly sworn to keep it secret. Thus printing, like architecture, was originally a system of freemasonry. The fame of Coster and his invention of printing daily extended, and he grew in wealth; but wealth brought with it trouble, as indeed it ever does, and this, too, in the hateful form of ingratitude. Amongst Coster's sworn workmen was one John Guttenberg, a native of Mentz, or Mayence, as it is more commonly called, the capital of a province in the grand duchy of Hesse Darmstadt. Guttenberg was a man of good family; but he had been forced by poverty to seek a livelihood in a foreign state. Coster took him into his service, and Guttenberg, being possessed of much talent, quickly learned the new art. He seems to have been treated kindly by Coster, perhaps out of pity for his misfortunes, probably to keep him true to his oath. But the temptation was too great for his fidelity. On Christmas-eve, 1439, while Coster and his family were at church, celebrating the festival of peace and good-will

to all men, Guttenberg seized the opportunity, stole a quantity of his master's type, and fled no one knew whither.

Coster's discovery and Guttenberg's roguery were for many years afterwards a famous story amongst the citizens of Haarlem. Any connection with the history of Coster, was regarded as something worth boasting of. Thus one Cornelis, a bookbinder, who had worked in Coster's printing office, would relate the many experiments his master had made, and the many disappointments he had experienced, before he was rewarded by success. He would vent his indignation at the manner in which Guttenberg had robbed Coster of his secret. "Cursed is my fate," he would exclaim, with tears running down his face, "that I should have shared my bed with such a wretch. If he had been taken alive, I would have willingly executed him with my own hands." Nicholas Galius, an old schoolmaster, again, used to relate that he had heard and seen Cornelis speak thus with his own ears and eyes. And thus the story was handed down from mouth to mouth, generation by generation, until it reached Adrian the Younger, who wrote a history of Holland in 1578. The truth of the story has been doubted; but the evidence strongly favours the belief that Coster was the inventor of moveable wooden types, as well as the presumption that the man Jan who robbed him was no other than John Guttenberg. A

passage in the work of Henry Speichel, a Dutch poet of the sixteenth century, offers a remarkable confirmation. "Thou, first, Laurentius," he writes, addressing Coster, "to supply the defect of wooden tablets, adopted wooden types, and afterwards didst connect them with a thread to imitate writing. A treacherous servant surreptitiously obtained the honour of the discovery. But truth itself though destitute of common and wide-spread fame—truth, I say, remains." Nor is this statement actually impugned by the citizens of Mentz, although they claim the honour of the invention for that city, and have set up a statue to Guttenberg as the inventor of printing. For the inscription placed upon Guttenberg's house as early in the history of printing as the year 1547, declares that it is "as a token in honour of John Guttenberg, of Mentz, who first invented printing letters *made of metal*, and thus deserved well of all the world." These words admit, rather than contradict, the statement that Coster invented moveable wooden types, which contained the principle of metal types, just as the wooden printing press contained the principle of the iron press which has entirely superseded it. Wooden types were superseded by metal types only because they were not sufficiently strong to bear the requisite pressure. Wooden presses have been superseded by iron presses only because they were not sufficiently strong to give the

requisite pressure. But whatever differences of opinion may exist elsewhere, there are none on the point amongst the citizens of Haarlem. A collection of books printed by Coster is the most precious part of the public library. The market-place has been adorned by his statue. The fourth centenary of the invention was celebrated in 1824 with great ceremony, and as if to signalize the circumstance under which the first letters were cut, a monument in honour of the ancient "wanderer through the woods," was erected in the Haarlem Bosch, a delightful grove near the town, famous for the great height and beauty of its trees.

Guttenberg escaped with his booty to Amsterdam, from thence he removed to Cologne, and finally he settled in his native place, Mentz. He immediately commenced operations as a printer. "It is a known fact," says Adrian the Younger, "that within the twelve months, that is in the year 1440, he published the *Alexandri Galli Doctrinale*," a grammar at that time in high repute, "with *Petri Hispani Tractalibus Logicis*, with the same letters which Laurentius used. These were the first products of his press." And now it is necessary to introduce another John Guttenberg, the existence of whom has aided in making "confusion worse confounded." In the early history of printing, Guttenberg had a younger brother, and they were distinguished from each other by their surnames, the elder

being called John Geinsfleich and the younger John Guttenberg. It was not an uncommon thing for two brothers to bear the same Christian name in the days in which the Guttenbergs lived. The younger Guttenberg, like the elder, was a man of ability; he had also been forced to leave Mentz, having been implicated in an insurrection; and he was also driven to earn a subsistence by mechanical labour. While the elder Guttenberg was in the service of Coster, it would appear that the younger brother had visited him, and picked up a knowledge of the existence of the new art. He went to Strasbourg, and there he entered into a partnership with some of its citizens, binding himself to disclose to them an important secret, by which they should make their fortunes. But he had not yet acquired the secret himself. He had only discovered that there was a secret art of printing. He wasted his own time, and the money of his partners, in fruitless experiments. He never printed a book; they never received back an obolus of their money. Yet Strasbourg in after years, claimed the honour of being the birthplace of printing.

The elder Guttenberg, in the meantime, continued to reside at Mentz. His business largely increased, so that he required additional capital and assistance to carry it on. The first was supplied in 1443, by a wealthy goldsmith of the city, named John Faust, who

engaged in printing, either for the sake of the profit, or the fame of practising what was then

Statue of Guttenberg.

considered a noble art. The second he obtained in 1444 from the younger Guttenberg, who had left Strasbourg overwhelmed by debt,

besides having been condemned in a lawsuit instituted by his disappointed partners. Until this period, Guttenberg had used wooden types; but these continually broke under the pressure required to obtain a good impression. As the material used was too soft, nothing was more natural than the idea of substituting for it something more durable. The Guttenbergs thereupon made their types of metal; and to this extent, but no farther, they were the inventors of printing. The Abbot Trithemius, the most able and trustworthy supporter of the case of Mentz, does no more than assert that about the year 1450 "the art of printing *and casting single types was found out anew*," and again, "the wonderful, and until then unknown art of printing books *by metal types*, was invented and devised by John Guttenberg." If the art was found out anew, then it must have been known before. It is probable that the use of wood letters preceded the use of metal letters, just as in our days, a wooden mould always precedes a metal casting.

The first book printed with cut metal types was the Holy Bible. This is the "Mazarine Bible," so called because after the existence of the edition had been forgotten in the lapse of time, a copy of it was found in Cardinal Mazarine's library at Paris. It was printed in a large, handsome Gothic character resembling manuscript, and consisted of 637 leaves, with two columns of print on each page. The work-

manship of the edition, remembering the circumstances under which it was executed, is worthy of the subject. The printers lavished time, labour, and money on it, and it was by far the handsomest book that had been printed up to the time of its appearance. Four thousand florins were spent in producing the first twelve sheets, and seven years had passed before the work was finished. It was published in the year 1450 or 1452. And here it may be convenient to state the manner in which the first books were printed. Only one side of the leaf was printed on; the first letter of the chapter was left blank, and was afterwards painted, and blanks were left for Greek quotations, which were written in. At first thin vellum was used for printing on, but it was soon superseded by paper.

In the year 1450 the elder Guttenberg ceased to be the partner of Faust. In the following year Faust entered into partnership with the younger Guttenberg. But the art of printing, although so great a benefit to the rest of the world, seems to have brought nothing but misfortunes upon the Guttenbergs. A quarrel took place respecting the money which Faust had advanced for carrying on the business. The younger Guttenberg apparently considered that his skill was equivalent to his partner's capital. Faust commenced a lawsuit, and Guttenberg was condemned to repay the money. Guttenberg was thus driven from the

partnership in the year 1455, and Faust took possession of the stock of types in payment of the debt which he had not been able to obtain in money. A most important discovery was made a year or two afterwards. Faust had a servant named Peter Schoeffer, who shared his master's love of the art, and desired equally with him to improve it. After many trials Schoeffer succeeded in casting metal types. It should be remembered that the metal types previously used were cut, not cast; they were carved on solid pieces of metal, not shaped in a mould with melted metal. But Schoeffer now formed them with the punch and the matrix, tools which we proceed to describe. Imagine a piece of well-tempered steel, one end of which is cut into the shape of a letter of the alphabet. This is a punch. The letter is struck into the surface of a piece of copper, and when the copper has received the impression it is called a matrix, and it is used as a mould, in which the types are cast by pouring hot liquid metal into it. Of course, as many punches and matrices are used, as there are letters in the alphabet.

Schoeffer having privately made punches and formed matrices for the whole alphabet, cast some letters. He then showed them to his master in triumph. Faust was greatly surprised and delighted by the diligence and ability of his servant. A great thing had, in truth, been accomplished. Casting not only rendered the manufacture of types more easy, and, therefore,

less costly, but it increased the beauty of printing. For though the metal types cut by hand greatly resembled each other, still there was some difference, and this gave an irregular appearance to the printing. But those cast in the matrix were alike, being really exact images of each other, and were therefore far more beautiful. Faust praised his servant, took him into partnership, and finally gave him Catherine, his daughter, in marriage. At first the metal used was not hard enough to bear the force of the impression, but the defect was soon remedied by mixing another substance with it, just as more modern typefounders mix antimony with lead for the same purpose. The first book printed with these improved types was *Durandi Rationale* in 1459.

We have already said that engraving preceded letter-press printing. But printing from engravings, as it is now practised, was not discovered until after printing with types. It originated in the year 1460 with a goldsmith, named Thomas Finneguerra, at Florence. He was, like many others at that time, a worker in *niello*. This consisted in engraving silver ornaments, cups, hilts of swords, &c. After the design had been cut, it was filled in with a black composition formed of silver and lead, called *niello*, and this produced the effect of light and shade, and gave the design very much the appearance of a print. But before filling the design with the *niello*, it was usual to prove the correctness of

the engraving by rubbing into it a mixture of oil and charcoal; this, by making the lines black, enabled the artist to form an opinion of his work. One day, Finneguerra, whilst thus engaged, spilt some melted sulphur on the design. and on removing the sulphur he found that it had brought away with it the mixture of oil and charcoal which had filled the lines, and exhibited an exact copy of the design. He saw at once that what could be done with sulphur, might be done still better with paper. He therefore filled the lines of the design with ink, placed on the ink a sheet of moistened paper, pressed the paper down, and in this way printed the first engraving.

Guttenberg the younger, after he had separated from Faust, found a patron in Conrad Humery, who held the office of Syndic of Mentz. By his assistance Guttenberg was enabled to open another printing-office. He continued to use cut metal types. Amongst other books he published the *Catholicon*. in which he ascribed the honour of the invention of printing to the city of Mentz. Faust and Schoeffer had previously declared themselves the inventors of it. Though the parties were at variance as to the origin of the art, they agreed in keeping it secret. It was, indeed a common practice of the early printers to pretend that their books were manuscripts, their object being not simply to conceal the art, but also to obtain the high prices which were given for manuscript books.

Books were curiosities because they were few; they were costly because to write one of them was a hard and tedious work. From the earliest times, in truth, they had been as valuable as houses and lands, and they were conveyed from the seller to the buyer, by notaries, in the same manner as estates. Thus Cicero, having bought the written books of Atticus, considered himself richer than Crassus, and despised fine villas and gardens. Thus Ptolemus Philadelphus, one of the Greek kings of Egypt, for whom the Holy Bible was first translated from Hebrew into Greek,* gave fifteen talents and a great convoy of provisions

* This was the Septuagint version, so called, it is said, because it was made by 72 translators, six from each of the twelve Jewish tribes. Ptolemy, who lived about 250 years before Christ, was the son of the founder of the Alexandrian Library, a vast collection of books or manuscripts, the destruction of which has always been considered an irreparable loss to learning. This was brought about by the very anxiety to save it When the Mahomedans captured Alexandria in the year 640, the conquerors took an account of everything that they considered valuable, in order that the Caliph might make a fair distribution of the spoils amongst the soldiers. Amru, the Mahomedan general, had formed an intimacy with a learned man, commonly called John the Grammarian, who thinking that no value was set upon the Royal library, begged that it might be given to him. Amru replied that he would write on the subject to Omar, who had succeeded Mahomet as Caliph, since he dared not dispose of a single book without asking his authority. He forthwith wrote to Omar, describing the merits of John, and asking whether the books might be given to him. Omar's reply was short and terrible. "The contents of these books," he said, "are either

to the Athenians, besides exempting them from the payment of all tribute, for the manuscripts of the tragedies of Eschylus, Euripides, and Sophocles. Thus Panorme, gave 120 golden crowns for a copy of Livy, calling it the "King of Books," and having done so, asked his friend Alphonsus, king of Sicily, "whether I or Poggius have done the best; he, that he might buy a country house near Florence, sold Livy, which he had writ in a very fair hand; and I, to purchase Livy, have exposed a piece of land for sale?" The inducement held out by the value set on manuscripts being so great, the early printers attempted to hide their light under a bushel. They never sold their books as printed books, if they could avoid it. This duplicity, however. almost proved fatal to Faust, and indeed, for a time, cost him his liberty. Soon after the partnership with Guttenberg had been dissolved, Faust proceeded to Paris to sell the expensive and beautiful edition of the Bible which had been printed in his office four yours previously. One copy of it he sold to the king for 750 crowns, and another to the Archbishop of Paris for 300 crowns. Other

similar to the Koran or different. If they are similar, the Koran is sufficient without them; if they are different, they are pernicious. Let them, therefore, be destroyed." Amru obeyed the order. The books were distributed as fuel amongst the 5000 baths of the city. and it took six months to burn them, so great was their number; it was 1,000,000, of which 200,000 volumes had been presented to Cleopatra by Mark Antony

copies he sold to commoner people for 60 crowns the copy. Each purchaser thought that the world could not produce such another book as that which he possessed, and it was shown as a curiosity and a treasure. In this spirit, the Archbishop of Paris carried his book to the king, and, much surprised, the king produced his own. The two books were compared and discovered to be exactly alike. The initial letters, and other ornaments painted with the hand were, indeed, different; but the pages, lines, words, and letters of the one presented a magical resemblance to the pages, lines, words and letters of the other. The king and the archbishop were utterly confounded. They were convinced that the books had not been written in the ordinary manner, because one man could nôt have written them in a lifetime. They were convinced that they could not have been written by more than one hand, because it would have been impossible for two or more hands to write so strikingly alike. Moreover they discovered that a large number of copies had been sold. What could they believe? They came to the conclusion that Faust was a magician, and that the holy books had been produced by the help of Satan. Had they turned over its Heaven-inspired pages, their superstitious ignorance would have been dissipated. They would have learnt that "if Satan rise against himself and be divided, he cannot stand, but have an end." They

must have felt that Satan could not have had a hand in a book which may save man from his arts. Yet Faust was put in prison as a magician, and orders were given that he should be tried for sorcery. And, then, in the fear of death, he disclosed the simple art of printing; and the parliament of Paris ordered him to be set at liberty in their admiration of so noble an invention. Before he had quitted Paris, however, he was struck by the plague and died.

In 1462 the Archbishop Adolphus sacked the city of Mentz; the printing trade of the place was ruined; the workmen dispersed themselves in search of a livelihood; and thus effectually spread the knowledge of the art which their first masters had so carefully concealed. Even war may, therefore, have its blessings; good undoubtedly came out of evil in this instance. The elder Guttenberg died in this year, and his brother in 1468. Conrad took possession of the younger Guttenberg's printing office, as he had not repaid the money lent to him; but promised the archbishop that the types should not be sold except to a citizen of Mentz. Conrad broke his word, however, for he sold the types to one Nicholas Bechtermuntze of Altavilla, who in 1469 published a German and Latin vocabulary. A copy of this book is in the collection of the Duke of Marlborough at Blenheim. In the year 1471, Schoeffer still carried on the business of print-

ing at Mentz, having also taken one of Faust's kinsmen and Conrad Humery into partnership. With one or two exceptions copies of all the books printed by Faust, Guttenberg, and Schoeffer are in the British Museum.

Such is the most consistent narrative of the early progress of printing into which the existing materials can be woven. The subject is obscured by doubts, and the inquirer is continually impeded by contradictions which defy the most learned. "It is wonderful, but it is true," says Lemoine, "that the only art that can record all others should almost forget itself." The reasons for this are, however, plain. The art was originally a personal secret; it was used to counterfeit writing: to sell cheaper printed books at the prices of dearer written books; and it was practised secretly in several places, so that the few years which give priority to one of them, has been almost lost in the distance of time.

These things at least seem clear. The Chinese used block printing to multiply books, nine hundred years ago. Coster, of Haarlem, invented moveable wooden types; Guttenberg, of Mentz, invented *cut* metal types. Schoeffer invented *cast* metal types. These facts are reconcilable with each other, and form natural steps in the progress of the art. The sole honour of the invention is thus not given to one by disregarding the claims of another; but a portion of it is given

wherever it appears to be due. To no one person can be rightfully assigned the invention of the art, but to several must be awarded the merit of improvements which fall little short of the invention. Coster was clearly not the inventor of printing, for the Chinese printed before he did; nor Guttenberg, for Coster printed before he did. Yet it is hardly possible to say that the Chinese invented printing, for, except in the principle, there is not the slightest resemblance between the Chinese and European systems. The case of printing, in short, is similar to that of steam. The steam-engine is not the invention of one mind, but of many minds; it is not one contrivance but several contrivances, put together by several contrivers. One man has made use in it of that law of nature by which the house fly is enabled to walk on the ceiling of a room; another man of that law by which the planets move round the sun; and another man of that law by which air and other fluids rush into any place which is empty. Other men have contrived to make the steam-engine feed itself with water, and regulate its own motions, and cure its own defects, and guard against its own dangers. Neither of these improvers was the inventor of the steam-engine; yet if either of the improvements had not been made, the steam-engine could not have reached its present perfection. So it is with printing. Little by little, and

step by step, it has advanced. At first it was the mere stamping of one substance upon another, as a seal on clay, leather, or lead; then a wooden copy of a page of writing was made and printed on paper; then moveable wooden types were used; then cut metal types; then cast metal types: at first the impression on paper was obtained by the friction of a brush; then by the pressure of the naked hand; then by a screw; then by a wood press; then by an iron press; and, finally, by an elegant and rapid machine. In this way the art has progressed during the last four centuries until it has reached its present high state of perfection. Many persons have greatly assisted in improving it; but no one can claim the invention as his own sole work.

The art, having been once disclosed, spread with the swiftness of good tidings. The process itself was as simple as the advantages of the invention were clear. It was universally regarded as an art which gave reputation to the people amongst whom it flourished. It was practised in Italy, at Subiaco, in the Roman states, in the year 1465; in England, at Oxford, in 1468; in France, at Paris, in 1469; in Spain, at Barcelona in 1475. In the year 1490 it also reached Turkey, and in 1560 it penetrated into Russia. The art improved as rapidly as it extended. The shape of the types was changed from Gothic or German, to semi-Gothic, a kind of

Roman letter, first used at Rome in 1467. Three years afterwards, Jenson of Venice improved the Roman letters, giving them the proportions which that kind of type retains at this day. In 1488, Aldus, a learned printer, also of Venice, invented Italic letters, and the Aldine printing in after years became famous for its beauty. The object sought by the use of Italic was to get rid of the great number of abbreviations then used in printing. Greek types had been cast at Mentz in 1465, and was followed in 1482 by Hebrew types. Aldus printed the works of nearly all the Greek authors in their own language in rapid succession, and with singular beauty. Learned men became printers. Others took a pride in correcting the press; and the printers published the names of their eminent assistants on the title-pages, as those of editors are now used, to invest the work with a higher guarantee of character and ability.

But the art had to encounter great opposition. It was regarded with suspicion, because it appeared to be so wonderful, and because, in order to conceal the process, it had been so mysteriously practised. Faust, as it has already been stated, narrowly escaped punishment as a sorcerer. "The Printer's Devil" is a character originating with the art itself, and furnishing an amusing proof of the light in which the art was formerly regarded. It

was also bitterly opposed, because a craft was endangered by it. In England, for instance, a book was published by reading it over three days successively before the members of one of the universities, and if it was approved of, persons called brief-men, were permitted to make copies of it for sale. These copyists formed a numerous class throughout Europe, and they were appalled by the invention of printing. It not only multiplied books faster, but better, than they could. It rendered their art useless, and took away their bread. But printing furnishes a striking example that the improvement of an art increases employment, instead of diminishing it. "A single printer can, indeed, do the work of at least two hundred writers, and at first sight this seems a hardship; for a hundred and ninety-nine people might have been, and probably were, thrown out of their accustomed employment. But what was the consequence in a year or two? Where one written book was sold, a thousand printed books were required. The old books were multiplied in all countries, and new books were composed by men of talent and learning, because they could then find numerous readers. The printing press did the work more neatly and more correctly than the writer, and it did it infinitely cheaper. What then? The writers of books had to turn their hands to some other trade it is true; but type-founders, paper-makers,

printers, and bookbinders were set to work by the new art or machine to at least a hundred times greater number of persons than the old way of making books employed. If the old pen-and-ink copyists could break the printing presses and melt the types that are used in London alone at the present day, twenty thousand people would at least be thrown out of employment to make room for two hundred at the utmost; and what would be even worse than all this misery, books could only be purchased, as before the invention, by the few rich, instead of being the guides and comforters and best friends of the millions who are now within reach of the benefits and enjoyments which they bestow."*

The value of the art of printing may be illustrated by the following true story. Seventy years since a widow, named Lee, lived in the village of Longnor, near Shrewsbury. She was very poor, and had to support three children with the labour of her own hands. The eldest of the children was a boy, who, at the age of twelve years, was put apprentice to a carpenter, through the charity of a neighbouring gentleman. The boy underwent hardships which boys even of his age will seldom endure patiently; but he had no father to protect him; he knew that his mother, having still two children to support, was unable to provide for him better; and he judged it

* "Results of Machinery."

best to submit to his lot. The boy was fond of reading, and he read every book which fell in his way at his lodgings. But he was occasionally confounded by Latin quotations, and was, therefore, unable to comprehend the subject fully. At the age of 17, then, he determined to learn the Latin language, a determination in which he was confirmed by seeing many Latin books and hearing Latin read, whilst working in a chapel attached to the residence of Sir Edward Smith, a Roman Catholic gentleman, at Acton Burnel. He bought a Latin grammar at an old book-stall, and soon learnt the whole of it by heart; then he bought a Testament, and then a book of exercises. One day, emboldened by the progress he was making, he asked a priest whom he frequently saw while working at the chapel, to explain some things in the language which he could not understand. The priest uncivilly repulsed him, selfishly saying, "Charity begins at home." But the boy did not despair. He was mortified, indeed, but he was also stimulated to do that for himself which another had refused to do for him; and he resolved from that time, if it were possible, to excel the priest himself in the knowledge of Latin. But there was one thing even more powerful than unkindness in opposing him; it was poverty. He was at that time only an apprentice; he had but six shillings a week to live on and to pay for his lodging and washing; yet out of this, with much stinting of stomach, he

resolutely saved something that he might increase his stock of knowledge. Soon after the priest had refused to assist him, the boy's wages were raised a shilling a week; the next year they were raised a shilling a week more; and during that time he read the Latin Bible and all the best Latin authors. It may be asked how, with his scanty wages, he obtained all these books? He bought one book, read it, and then sold it; the price he got, with a little more added, enabled him to buy another; and having read this he also sold it to obtain the next. By thus getting one book at a time, he got all that he desired. He was now out of his apprenticeship, and having mastered Latin, he determined to learn Greek. Again he bought and sold book after book; and having acquired Greek, he thought he might just as well attempt Hebrew. He now seemed to be fast drawing to the summit of his wishes, having really become very learned. But his pursuit of knowledge was not uninterrupted; it was retarded by frequent suffering from inflammation of the eyes; and his acquaintances threw every possible discouragement in his way. They could not understand what a poor carpenter's lad could want with learning. But habit, and a fixed determination to proceed, had now made study his greatest happiness. His daily work done, he returned to his books, rather as a source of recreation and rest; and the bodily privations which he suffered were

amply repaid by the intellectual gratification which could be felt only by a mind so nobly actuated. One day chance threw in his way a Chaldaic book, and having the Chaldaic grammar in one of his Hebrew books, he soon learned to read it. He proceeded next to the Syriac language, and also mastered that. During his former studies, he had occasionally looked over portions of the Samaritan language, and as the Samaritan Pentateuch differs very little from the Hebrew, except in a change in the letters, he found no difficulty in reading quotations of it; but with quotations he was obliged to content himself, as books in the Samaritan were scarce and costly, and therefore were entirely out of his reach.

The boy was now a man. He had reached his 25th year, and notwithstanding his outlay in books, had got together a chest of tools worth 25*l*. His master sent him into Worcestershire to superintend the repairs of a clergyman's house. And now he began to consider seriously the business of life. He thought he would relinquish the study of languages, perceiving that however excellent the acquisition might have appeared, it was useless to him in his position of life. He therefore sold his books, and turned over a new leaf, as the phrase is; he married, and looked to his calling as his only means of support. The prospects of the future, too, were bright, promises of advancement in his occupation having been made

to him by his friends. But a different and distressing appearance was soon afterwards given to his affairs. "Man is born to trouble as the sparks fly upward." A fire destroyed the house at which he was working; his tools were consumed; and all his hopes vanished. He was now cast on the world without a shilling in his pocket, without a friend to aid him, and without even the means of earning a living. This indeed he would himself have felt lightly, having always been the child of misfortune, but then the partner of his life was involved in his afflicting circumstances. Having no tools, he had no alternative but to turn his thoughts to some new course in life; and it struck him that his former studies might be made available. He determined to become a country schoolmaster, and therefore studied Murray's English grammar, and improved himself in arithmetic. Yet there was still a great obstacle in the way; he had no money to begin with, nor a friend to lend him any. He was at the point of despair, but Providence, though it tries a man, never deserts him:—

"The darkest day,
Live till to-morrow, will have passed away."

At this juncture, Archdeacon Corbett, having heard of his attachment to study, sought him out, listened to his story, and befriended him by getting him appointed head master of the Blue School at Shrewsbury. He took

the opportunity of acquiring the Arabic, Persian, and Hindostanee languages, from other learned men with whom he became acquainted. And now having obtained a firm footing amongst scholars, nothing could prevent him from reaping the reward of his industry and talent. Some friends provided him with money to enter Cambridge University, and he became a clergyman; he was chosen its professor of Arabic and Hebrew; the king appointed him a dignitary of Bristol cathedral; he made his name celebrated by many a learned book; and he died at a venerable age in 1852, one of the greatest scholars and most honoured men of his time and country. We have described, almost in his own words, the career of the Rev. Dr. Lee.

What books have done for Dr. Lee, printing has done for the whole world. Before the invention of the art, the great body of people in every country was sunk in ignorance. Learning was confined to a few persons; and these, if they had the inclination, had not the means of diffusing it. The poorest man in the present day is in a better position, in this respect, than the richest man was before printing had been discovered. The poorest man may now obtain the books which kings and princes and learned men once counted amongst their richest possessions. The poorest man may now store his mind with the best thoughts of the best minds of all ages; for printing has

placed all learning within the reach of almost all sorts and conditions of people. Printing has enabled men to instruct themselves in the ways of wisdom, both human and divine; to make knowledge serve them in earning their daily bread; and to enjoy in their leisure one of the most innocent of human pleasures. A child possessing a knowledge of the alphabet, holds the key which can unlock all the treasuries of learning. Printing, in short, has added to the learning of the learned, and instructed the unlearned; it has created new springs of success in industry, and new sources of contentment. Printing, as the visible form of knowledge, is, at once, a comforter and a guide.

Printing has above all aided in the strengthening and diffusion of religion. The early printers, as if it were really "the Divine art" which it was sometimes styled, employed themselves at first in printing the Holy Scriptures, Psalters, and other books of religion. "It is a very striking circumstance," observes Hallam, "that the high-minded inventors of this great art, tried at the very outset so bold a flight as the printing an entire Bible, and executed it with such astonishing success. We may see in imagination this venerable and splendid volume leading up the crowded myriads of its followers, and imploring, as it were, a blessing on the new art, by dedicating its first fruits to the service of Heaven." Remembering the

cheat which the early printers practised as long as they could, in selling their printed Bibles as written ones, we are forced to believe that they were actuated more by the love of money than of religion. Nevertheless, the fact remains that they were benefactors of the world. By multiplying Bibles, they diffused religion. There was very little religious learning before the invention of printing, and that little was confined to the clergy. Not one man in five hundred could spell his way though a psalm. A Bible never sold for less than 30*l.*; and, therefore, a copy of the blessed volume, inferior in beauty to those which every cottager may now command, cost more than very many of the clergy could afford to spend. But when printing cheapened the price of books, the Word of God ceased to be sealed up in a comparatively unknown tongue. It was translated into the common language; and the poor and simple, as well as the rich and learned, were enabled to obey the command, "Search the Scriptures." Eloquent discourses delivered from the pulpit, too, which had previously passed away with the breath that uttered them, were perpetuated; heard by few they were made visible to many by being printed. Commentaries were written, because form and texture could be given to ideas and opinions. Thus the "knowledge which maketh wise unto salvation" spread farther and farther. Learned men, without seeing

each other, co-operated in establishing truth, comparing, testing, and amassing their thoughts to the advantage of future generations. A grand effect was soon witnessed. "To the art of printing," says Dr. Knox, "it is acknowledged we owe the Reformation. It has been justly remarked, that if the books of Luther had been multiplied only by the slow process of hand-writing, they must have been few, and would have been easily suppressed by the combination of wealth and power; but poured forth in abundance from the press, they spread over the land with the rapidity of an inundation, which acquires additional force from the efforts made to obstruct its progress."

The introduction of the art of printing into England has generally been assigned to William Caxton. But there is much reason for believing that, though he may have been the first English printer, Caxton was not the first person who practised the art of printing in England. For a book, containing forty pages, and entitled *Expositio Sancto Jeronimi in Simbolum Apostalorum ad Papam Laurentium*, has been found in the University of Cambridge, and at the end of it is a statement that the printing of it was completed at Oxford on the 17th of December 1468. The style of the book bears out its claim to superior antiquity amongst books printed in this country. It is printed in the

German type, very nearly similar to that which Faust and Guttenberg were using in 1468; while Caxton employed in his first books a different style of letter, something between this German and the old English types.

In the year 1664, Richard Atkins, Esq. published, by order of the government, a record entitled, "The Origin and Growth of Printing, collected out of the History and Records of the Kingdom." It forms a very curious narrative. Mr. Atkins states, that as soon as the art had begun to make a noise in Europe, Thomas Bouchier, the Archbishop of Canterbury, induced King Henry the Sixth to use all means to obtain a printing-mould, for such was then the term used to describe the invention. The king, 'a good man, fond of works of piety, listened to the advice, and consulted with the archbishop how to effect the object. The printers at that time, as it has already been shown, were bound by oath to serve their masters, as well as to keep the secret of the art. It was, therefore, doubtful whether a printing-mould and a printer could be obtained even by a king. It was at last determined that some persons should be sent to Haarlem, and endeavour, by offering a large reward, to draw off some workmen. A large sum of money it was thought would be required to accomplish it, and the archbishop having subscribed 300 marks, King Henry made it up to 1,000. The

management of the business was entrusted to Mr. Robert Turnour, master of the robes to the king, and he obtained the assistance of William Caxton. Caxton in his youth had been an apprentice to a London mercer, a class of men who in those days were general merchants, often uniting a love of literature with the pursuits of commerce. Caxton seems to have acquired a taste for letters while he learnt his trade. His master having died, he determined to visit foreign countries; and it may be added here, that during the thirty years which followed, he resided by turns in Brabant, Flanders, Holland, and Zealand. Caxton's assistance was the more valuable to Turnour because his trading connexion with the LowCountries gave him a plausible pretence as well for going as remaining there; and Turnour might also visit him as a friend without creating suspicion. But while Caxton went abroad openly in his own proper person, Turnour disguised himself. He shaved his head and beard, and wore strange clothes. They went first to Amsterdam, and then to Leyden; but they did not dare to visit Haarlem, as the authorities were very watchful, and had imprisoned several persons who like themselves had come to steal the art. At length the 1,000 marks were spent in expenses, and in gifts to persons likely to forward their object; but the king sent Turnour 500 marks more, having been informed that the work

failed of completion only for want of money. So it turned out, for one Frederick Corsellis, an under workman in a printing-office at Haarlem, had yielded to the temptations of the Englishmen; and late one night he stole away in disguise from his fellows, embarked in a Dutch ship which had been engaged for the purpose, and was soon wafted by a favourable wind to the city of London. But it was not thought prudent to set him to work in London, and the archbishop being chancellor of Oxford University, sent him there. Corsellis was, however, treated more like a criminal than a benefactor; for he was taken by a guard of men to the university, constantly watched lest he should make his escape, and he was not set at liberty until he had fulfilled his engagement to teach the art of printing. "So that at Oxford," says the record, "printing was first set up in England, which was before there was any printing-press in France, Spain, Italy, or Germany, except the city of Mentz, which claims séniority as to printing, even of Haarlem itself, calling her city *Urbem Moguntinam artis typographica inventricem primam;* though it is known to be otherwise, that city gaining the art by the brother of one of the workmen at Haarlem, who had learnt it at home of his brother, and afterwards set up for himself at Mentz. This press at Oxon was at least ten years before there was any printing in Europe,

except at Haarlem and Mentz, where it was new born."

The record has been pronounced a forgery. The story about Corsellis, it has been asserted, was concocted by Atkins, in order to prove that printing was the prerogative of the Crown, in opposition to some privileges claimed by the Company of Stationers. But even supposing that Atkins had dared to impose on the government in a state paper, still the evidence of the book printed at Oxford stands unshaken. That book bears date 1468, and Caxton, it is certain, did not commence printing in England until 1474. It may be, as some persons have suggested, that the date of the Oxford book is a mistake; but there is no proof whatever that it is a mistake, and without some proof it must not be explained away. It may be true, that no other book was printed at Oxford for eleven years afterwards, as it is urged to show that there was no printing-press there. But Atkins tells us the reason why. He says that the press was removed, first to St Albans, and next to London, because it was found very inconvenient to have the sole printing-office in England so far from the capital and from the sea. But if the testimony of Atkins be objected to, following out the assertion that the record is a forgery, still it remains to be proved that eleven years did actually pass without any book having been printed at Oxford. It may be, that the books printed

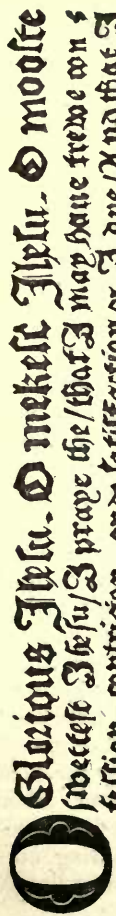
there have been destroyed in the lapse of time, just as the early books printed in other places have disappeared.

Caxton, in the year 1464, was entrusted by King Edward the Fourth, who then usurped the Crown, to negotiate a treaty of commerce with the Duke of Burgundy. The Duke's wife was King Edward's sister, and Caxton afterwards entered into her service. Knowing his love of learning, she seems to have urged him to translate some French book into English, and he selected Le Fevre's History of Troy. He commenced the translation on the 1st of March 1468, at Bruges, and finished it in 1471 at Cologne. Several of the workmen who had been driven from Mentz by the sacking of that city, were living in Cologne at this time, and amongst them were Wynkyn de Worde, Theodore Roode, and Thomas Hunt, an Englishman. Caxton, by their aid, got his book printed, and it is generally understood in a printing-office of his own. Certain it is, that he had acquired the art previously to the printing of the book; for at the end of it, he says so. "Thus end I this book, and forasmuch as in writing the same, my pen is worn, my hand weary, and my eyes dimmed with overmuch looking on the white paper, and that age creepeth on me daily—and also because I have promised to divers gentlemen and to my friends to address to them as hastily as I might this said book, therefore I have practised and learned, at my great charge

and expense, to ordain this book in print, after the manner and form as you may here see, and is not written with pen and ink, as other books have been, to the end that every man may have them at once, for all the books of this story, named the Recule of the Historys of Troys, thus printed as you see here, were begun in one day, and finished in one day."

The last statement requires explanation, because it may create the mistaken notion that books were printed more rapidly in Caxton's days even than in our own. Supposing several written copies of a book had to be made, the writer would finish one before he commenced another, just as we write our letters, one by one; but the plan of printing a book is entirely different. A printed book is formed by a number of sheets of paper stitched and bound together, each sheet printed with the same number of pages—say, for example, 16. Now whether 100, or 1,000, or 10,000 copies of a book are to be printed, the first sheets of all of them—that is, all the 10,000 copies of the first sheet of 16 pages are printed; then all the copies of the second sheet of 16 pages are printed; then the third sheet, and likewise all the rest, until the work is completed—so that the whole of the copies of the book are begun at one time, and completed at one time; or, as Caxton says of the copies of his books, "begun in one day, and finished in one day."

Caxton returned to England and commenced the trade of a printer in the year 1474. He found a patron in Mulling, Abbot of Westminster, afterwards Bishop of Hereford, who gave him an old chapel in the Abbey for a printing-office. The spot now forms part of the site of Henry the Seventh's chapel. Caxton announced his vocation by placards, one of which is still preserved at Oxford. It says: "If it please any man, spiritual or temporal, to buy any pyes of two and three commemorations of Salisbury use, printed after the form of this present letter, let him come to Westminster into the Almonry, at the rede pale, and he shall have them good and cheap." The Pye was a book of rules for regulating the Church service. The first book printed by Caxton in England was the "Book of Chess," a title which sufficiently describes the nature of the work. He used metal types; and probably from this originated the idea that Caxton was the first printer in England; just as Guttenberg was pronounced the inventor of printing, because he was the inventor of metal types. The runaway Dutchman, Corsellis, had used wooden types. Caxton's first types were of a sort called *secretary*, a name now unknown amongst printers. In 1482, he added another sort which showed much improvement; and in 1490 another sort which was still better. Caxton, indeed, made great improvements in the shape of the Gothic


O gracious Jhesu. O meke Jhesu. O moste
sweete Jhesu/I praye the/that I may have frewe on
fession contrary and satisfaction or I dye/And that I

black letter; and viewing it simply as an imitation of ancient writing, it has never been surpassed. These are specimens of it.

In 1483 there were only four printers in England—Caxton, at Westminster, Roode and Hunt at Oxford, De Machlinia in London, and a fourth, name unknown, at St. Albans. De Machlinia, it has been said, printed in England even before Caxton. The unknown printer at St. Albans may have been Corsellis or his successor, since Atkins says, that the printing press set up at Oxford was removed thither for the sake of convenience. Caxton seems, however, to have been the greatest printer of his time. He produced no less than 62 books; ten of them related to theology, and the remainder to chivalry, plain and romantic history, and manners and customs. The printing of the Bible, which occupied the foreign printers so generally at this period, was forbidden in England. Caxton deserves respect not only as a printer, but as an author. He

worked with his pen, as well as with his types; translating many books from the French, and thus spreading new ideas amongst his countrymen. He was apparently an honest and modest man, a character which he preserved until the end of his life, though the novelty of his art brought the temptations of high patronage and of riches. Kings and nobles were amongst his employers; and it has been asserted that, as the King's sworn servant, he paid a share of the profits of the art to His Majesty.

Caxton died about the year 1491. He was succeeded in his business by Wynkyn de Worde and Richard Pynsent. The first, who had accompanied Caxton from Cologne, was a most accomplished man, and he excelled his master in the art. He introduced the Roman letter into England, and the shape of his types was retained by the printers for two centuries afterwards. The punches and matrices he used in casting his types were in existence as late as 1758. The art grew famous in England as years rolled on; and to encourage it, extraordinary privileges were conferred upon printers. Thus Richard the Third interdicted foreigners from using any handicraft in England, except as servants to natives, but he expressly excepted printing. This privilege was, however, taken away by Henry the Eighth, because it had become unnecessary, the English having outstripped their foreign competitors in excellence.

Yet, as printing became cheaper, it did not become better. It retrograded, rather than improved, as it should, with the progress of time. But strange as the fact appears it may be very naturally explained.

Type-founders.

Anciently a printer was what we should now call a "Jack of all trades." Just as the weaver made his own loom and shuttle, so the printer cut the punches, formed the matrices, and cast the type himself. But this system was terminated by law. In the year 1637 the Star Chamber decreed that there should be no more than four founders of letters at one time in England, and that the vacancies as they occurred should be filled up either by the Archbishop of Canterbury, or the Bishop of London, and six other high Commissioners. The object of the Star Chamber was to prevent the secret printing of sedition. But though the restriction may have served this purpose, it retarded the improvement of printing. The printers, being debarred from casting type for themselves, imported it from Holland. The Dutch type, too, was the best made. For whilst the four English type-founders, working entirely by the eye and the hand, and guessing the proportions of the letters, had done little or nothing to improve the shape, the numerous Dutch type-founders, emulating each

other, had carried type-founding to a high state of perfection. Moxon, the author of a work called *Mechanic Exercises*, published in 1667, tells us that having magnified some very small Dutch letters by means of a glass, he was astonished to witness their beautiful proportions. The thickness, shape, and all the other features, he says, were as true as if they had been set off by a pair of fairy-like compasses. But no sooner was the decree of the Star Chamber repealed in 1693, than type-founding began to make progress in England. William Caslon was the first person who became eminent in the art. About the year 1700, Caslon was employed in cutting letters and ornaments used by bookbinders, and in engraving on gun barrels. He had executed some punches for lettering the backs of books so beautifully that he was encouraged by Mr. Watts, an eminent printer, to attempt cutting punches for type-founding; and he was first employed by the Society for Promoting Christian Knowledge, for which he executed a beautiful Italic fount in 1722. Caslon grew even more expert as he gained experience; and the result was, that the tide turned in the art of type-founding; for instead of type being imported into England from Holland, it was exported from England to Holland.

In 1750 John Baskerville greatly improved the art of type-founding. Baskerville was a man of active mind and versatile talents, at

one time following the vocation of a schoolmaster, at another that of a japanner, and lastly that of a type-founder and printer. Thousands of pounds which he acquired by japanning, were exhausted by his experiments in printing. He had so much difficulty in pleasing himself, that he spent 600*l.* before he had cast a single letter to his taste. He manufactured his own presses, ink, paper, and, in truth, the whole of the apparatus used in the trade. His printing was very beautiful, the letters used being of slender and delicate form. The Italic letters are distinguished beyond all comparison by their elegance, freedom, and perfect symmetry; and the books printed by him possess, even at this day, a high value throughout Europe, for accuracy as well as for typographical beauty. Indeed, so elegant were his types, that in 1791, four years after his death, a literary society at Paris purchased them for 3,700*l.* Yet so little taste existed during Baskerville's lifetime for good printing, that he could not get employment. The booksellers preferred the wretched printing that was then common, although Baskerville offered his superior work for an advance of 5*l.* per cent. on the ordinary prices. No wonder, then, that he declared himself heartily tired of the business of printing, and that he repented ever entering into it. "Is it not to the last degree provoking," he wrote to Dr. Franklin, "that after having

obtained the reputation of excelling in the most useful art known to mankind, I cannot get even bread by it?" Baskerville, we may add, was very eccentric. Each panel of his carriage was a perfect picture, which might be considered a pattern card of his trade. He was buried, as he had desired by his will, in his own garden at Birmingham. His grave was covered with a cone of masonry, but this monument was destroyed in 1791. Some persons of that town having assembled to celebrate the dawn of the French revolution, a riot was provoked, and the populace wreaked their vengeance on this tomb, Baskerville having avowed sentiments contrary to the doctrines of Christianity.

The art of type-founding was kept secret as long as possible, just as printing had been. The workmen were bound to silence; and so faithful do they seem to have been, that there was some risk of type-founding becoming one of the lost arts. "For," writes Moxon, "I could not learn any one had taught it to any other, but that every one that had used it had learned it of his own genuine inclination." If this be so, then the art of type-founding has been discovered again and again, as generation after generation has disappeared. Indeed so far had silence become the custom as regards type-founding, that when two Scotchmen, the celebrated Alexander Wilson and his friend Bain, commenced their experiments for the improve-

ment of types, they never attempted to gain any insight whatever into the processes then used, from the workmen employed in the existing foundries, though some of them might have given them information of which they stood in want. They failed repeatedly rather than be dishonest, and the merit by which their type-foundry at Glasgow has become the first in Europe, is all their own. Again, Mr. Caslon kept the mode of making punches a profound secret, when he was engaged in the work locking himself in a room specially arranged for the purpose. Yet this precaution provoked rather than prevented its discovery. Jackson, his apprentice, was as desirous of learning the art, as his master was unwilling to teach him; Jackson therefore bored a hole in the wainscot of the room in which the two Caslons, father and son, were at work, and overlooked their operations. Thus instructed, Jackson made a punch, and presented it to his master. But instead of being rewarded for his ingenuity, as Schoeffer was by Faust, Caslon beat him, threatening, moreover, that if he ever again offended by such cleverness, he should be sent to Bridewell. Jackson afterwards became a great type-founder.

There is, of course, a separate mould or matrix for each separate letter of the alphabet, and no less than 320 punches, and, of course, the same number of matrices, are necessary for the different varieties of letters, capitals,

and small capitals, Roman and Italic, which form a complete fount of type. The following

is the form of a letter, which we need scarcely say represents the shape of the interior of the mould. The mould is enclosed in two flat pieces of wood, and the metal is poured into it through a small funnel-shaped top. The metal used in making types is a mixture of lead, antimony, and tin, the proportions of which are the secrets of the different type-founders. The caster, after he has poured in the metal, jerks the mould upwards, by which the air is expelled, and the metal is forced into every part of it, so as to form the letters perfectly. Such letters as f and j, of small sizes, are now generally cast by the aid of a force-pump attached to the metal-pot, an improvement that saves the caster much time and trouble. The metal sets, or becomes solid, instantaneously after it has entered the mould. The process of casting, though apparently very primitive and clumsy, is performed with considerable expedition. A good workman will close the mould, cast the letter, open the mould, and remove the letter, in the eighth part of a minute; that is, he will cast 500 letters in an hour. The type made by hand is considered the best; but type is now made by

machinery at the rate of thousands instead of hundreds an hour. The machinery is, however, so complicated, that it would be impossible to describe it with any chance of being understood. Machines for making type, we may add, are not new in conception, although they have not been used until the last few years. Mr. Nicholson obtained a patent for a type-casting machine in 1790. Dr. Church, of Birmingham, also obtained a patent in 1825 for a plan of casting 75,000 letters an hour. Mr. L. J. Pouchée actually succeeded in casting 24,000 letters an hour; and a machine was made by Mr. Applegath, and was worked in the foundry at his printing-office, now Messrs. Clowes', in the year 1824. Machine-made type is used more generally in America than in Europe, where accuracy and beauty are more highly esteemed by the tasteful printer than cheapness.

There is an incident in the progress of typography which is worthy of especial notice. It is another proof that there are some men who are stimulated by the very difficulties which overwhelm most others. When Warren Hastings was Governor-general of India, there was a young writer, named Wilkins, in the East India Company's service, at Bengal. Hastings desired to improve the education of the persons employed by the Company; and Wilkins, having made himself acquainted with the language of the country, was enabled

to render him much assistance. Amongst other things, Hastings determined to print the grammar of the Bengalee language. The type had to be cast for the purpose. But owing to the intricacies of the strokes, the varying lengths, sizes, positions, and combinations of the Bengalee alphabet, it was found very difficult to form the punches. Mr. Bolt attempted it, but entirely failed, though he was an excellent Bengalee scholar. Many able artists of London, who had assisted, failed also. In this emergency, Wilkins applied himself to the task. He had neither models, nor practical knowledge to guide him, nor did he possess any trained mechanical skill; yet he succeeded by the force of determination and industry. He became the metallurgist, the punch-cutter, the type-founder, and the printer; and produced a grammar-book which forms an extraordinary instance of untaught skill. Afterwards he organized a printing-office, and greatly advanced the art of printing in India. On his return to England in 1786, he determined to print a Sanscrit grammar; and for this also he cut the punches, made the matrices, and cast the type. Only a single copy of a part of this work is in existence, for after Wilkins had printed 20 pages of it, his residence, at Hawkhurst in Kent, was burnt down, and his punches, matrices, and types were rendered useless. But Wilkins returned to the task; and the Sanscrit grammar which

he has given to the world, is a monument both of mental and mechanical ability.

A set of types was anciently called a *fund;* it is now called a *fount.* The different letters bear a fixed proportion to each other. Thus a fount containing 8,500 a's will have 1,600 of b; 3,000 of c; 4,400 of d; 12,000 of e; 2,500 of f; 1,700 of g; 6,400 of h; 8,000 of i; 400 of j; 800 of k; 4,000 of l; 3,000 of m; 8,000 of n; 8,000 of o; 1,700 of p; 300 of q; 6,200 of r; 8,000 of s; 9,000 of t; 3,400 of u; 1,200 of v; 2,000 of w; 400 of x; 2,000 of y; 200 of z.

The numbers vary in this way, because some letters are more used than others. It has been found, for instance, that 200 z's are sufficient where 12,000 e's are required. The capital letters of a fount are also proportioned to each other similarly to the other letters. To these must be added the spaces, which are small pieces of metal used to separate the words: being shorter than the letters, the ink in printing does not touch them, and, therefore, they make no mark on the paper, that is to say, they create a blank between the words. The spaces are of four sorts, hair, thin, middle, and thick spaces. Besides these there are quadrats, or larger spaces, to fill out the breaks in sentences; these are *n* and *m* quadrats, and two, three, and four *m* quadrats. The shank or body of the *m* quadrat, we may add, is a perfect square, and is, there-

fore, used in measuring, just as an inch is in a foot.

The different kinds of type are measured by one standard. This type is the sort called *pica*. Thus the large letters used in placards are called ten, twenty, or thirty lines pica, according to their size; that is, they are as wide, or as printers say, as deep, as ten, twenty, or thirty lines of pica.

For instance, this letter is "ten-line pica Egyptian," and is as deep as ten lines of pica put together. The following are the names, and specimens of types used in printing books:—

GREAT PRIMER.—This is sometimes called Bible text, as it is seldom used in printing any other books than the large folio Bibles. The French call it Great Roman.

ENGLISH.—This is used for printing Bibles, large books, and the body of handbills. The French and Dutch call it St. Augustine; it is supposed, therefore, that this sized type was first used by those nations in printing the works of that writer.

PICA.—This is the standard by which all the others are measured. It is more generally used than any other sort, especially in printing works of a high character. The French and Germans call it Cicero, it having been originally used by them in printing the Roman orator's epistles.

SMALL PICA.—This is the favourite type for novels. It is called *brevier* by the Germans, and *philosophie* by the French.

LONG PRIMER.—This sort is generally used for printing small books, or large books with close pages. The French call it *little Roman*, and the Germans *corpus*, it having been used by them, in the first instance, for printing the *Corpus Juris*.

BOURGEOIS.—This type is very much used, and generally forms the largest type employed in print-

ing newspapers. Bourgeois is a French word, signifying a citizen, and the name is applied to it in England as expressing the common use of the type. The French themselves call it *gaillarde*.

BREVIER.—This is employed in printing small cheap books, and for notes to larger type. It is supposed to have derived its name from the practice of using it to print breviaries, or Roman Catholic church books. The French call it *little text*, and the Germans *maiden letter*.

MINION.—This type is very largely used in printing newspapers, as well as in small prayer-books and bibles, and pocket editions of other works. The Germans call it *colonel*, and the French *mignonne*, or favourite.

EMERALD.—This is a small kind of minion, used chiefly in newspapers, and only lately introduced.

NONPAREIL.—This type is so called because it is far more beautiful than any other sort. It possesses all the beauty, without losing the distinctness of the larger sorts.

RUBY.—This is, like *Emerald*, an interpolation in the original order of types. It was, at first, a nonparell body with a smaller face. The French have no type which corresponds with it.

PEARL.—This is only used for miniature books and notes, and is legible only to persons possessing strong sight.

DIAMOND.—This is the smallest sort of type, and was first cut by the Dutch. A book printed in this type is, indeed, a curiosity, like the Lord's Prayer written on the size of a sixpence. The letters are so small, that 2,800 of them are contained in a pound weight. Strong eyes are required to read it, and still stronger eyes to arrange the letters for printing. We may add, however, that a type still smaller was cast by M. Didot, a French printer.

The above types are used in book printing; there are others which are used for placards. For instance, paragon; double pica; two-line pica; two-line English; two-line great primer; and canon, which is four times as large as pica. The types larger than canon have no distinct names, but are known as five, six, seven, twenty, or fifty-line pica, according to their size. Above 12-line pica, the letters are usually cut in wood—not cast in metal.

Type-founders all adopt the same names for these letters; but not always the same height and depth. The consequence is, that types cast at one foundry cannot very well be worked with those cast at another foundry.

A process has lately been introduced of facing the type with a very thin surface of copper by electrotyping.

Stereotype Printing.

Stereotype is a word derived from two Greek words, signifying *fixed* and *type*. Stereotype printing consists in printing from metal plates instead of from moveable types. If the reader will imagine a page not formed of single letters put together, but of a mass of letters cast in one block at the same time, he will understand what is meant by stereotype printing.

The following is the mode of making these metal plates. A page of the ordinary type (excepting the spaces, used in dividing the words, are higher) is set up in the usual way; not, however, to be used for printing, but merely as a model of the stereotype plates required. A small metal frame is then fitted to the page, with a rim which rises above the face of the type about $\frac{3}{4}$ of an inch, being the thickness of the mould. The face of the type is brushed over with oil, and then covered

with liquid plaster, which is brushed off again with a soft brush, and more plaster is poured on, and worked well into the type by the hand; and the face of this plaster, when it congeals, retains, of course, an exact resemblance of the type with which it has been in contact. The plaster cast, after being removed from the type, is baked at a great heat in an oven, and when it is rendered thoroughly dry and hard, it is ready to be used as a mould, or matrix, for casting the metal plates which are to be printed from.

The casting is a very delicate operation, and is effected in an iron box, which is made hot, and is just large enough to contain the mould. At the bottom of the box is a loose iron plate, perfectly smooth, called a *floating plate*. The mould, the edges of which are cut to allow the metal to run into it, is placed with its face downwards upon this plate. The top of the box is covered by a lid, which is screwed down tight, and holes are cut in the corners of the lid, so that the liquid metal may easily flow into the box. The box and its contents are then lowered, by means of a crane, into a large iron vessel containing molten type-metal. As the box sinks, the metal runs into it, through the holes in the corners of the lid, and under the floating plate, and both are forced up against the lid of the box by the bulk of the metal falling to

the bottom. The metal is thus effectively forced into every indentation of the mould. At the end of ten minutes, the box is hoisted out of the melted metal and cooled in water; the plaster mould is then separated from the metal cast, and the face of the cast presents an exact copy of the page of moveable types from which the plaster mould was taken. The metal plate is now examined, to remove any imperfection in the casting. The loops of the letters *a* and *e*, and similar letters, are liable to become filled up, owing to dust or air bubbles in the mould; this is remedied by removing the metal with a graver, and, if a letter is defective, by putting in moveable types. The back of the plate is then made smooth by a lathe, and the plate is mounted, or fastened on a block of wood, to make it as high as a page of common type. In this state, the plate is ready for printing by press or machine, in the ordinary way.

Stereotype printing is, then, in principle similar to the block printing which preceded the use of moveable types. It has really brought back the art, after a long course of improvement, almost to its original simplicity. At the commencement, the printers used solid blocks, on which were cut all the words composing a page; and, in stereotype printing, all the words of a page are cast in one block. The difference is this: the first was engraved

with a knife; the second is a copy from moveable types. Stereotype printing is useful in diminishing the cost of books, the sale of which is great or extended over many years, by enabling the publisher to print small editions without resetting the type, instead of having a large number printed at one time; enabling him thus to avoid the risk of printing a larger number of copies than can be sold. The first cost of stereotyping is greater than the first cost of the ordinary mode, because, not only have the moveable types to be set up, but the casts have to be made. But it is the cheapest plan in the end, as it reduces the outlay of capital, and prevents the loss which arises from printing more copies or less than are required of the book. Besides, it is a safeguard against errors.

The invention of stereotype printing has been attributed to a Dutchman of Leyden, named Van der May, the father of the well-known painter of that name. Van der May printed an edition of the Bible from solid plates at the end of the sixteenth century. But some years ago it was discovered, from an inspection of these plates, which were in the possession of his descendants, that they were entirely different from stereotype plates. They were merely common moveable types soldered together at the bottom. Stereotype plates, on the contrary, are castings from a

mould taken from moveable types. Van der May's process was also more expensive than common printing, instead of being less expensive, as stereotyping is; for the types could not be separated as they are after stereotyping; they were rendered useless for any other purpose; and the only advantage arising from the soldering was, that it prevented errors, as the letters could not become loosened and fall out of the form. Van der May clearly was not the inventor of stereotyping, and his plan died with him.

The French also claim to be the inventors of the process; but they have no better foundation for the claim than the use of some rude solid blocks in printing the calendar of a prayer-book. The real inventor appears to have been one William Ged, a clever goldsmith of Edinburgh. Ged was a man of much mechanical talent; and one day, in the year 1725, a printer asked him if he could suggest a remedy for the inconvenience which the Scotch printers suffered from the want of a type-foundry. At that time the type used in Scotland was procured from England and Holland. It struck Ged that the quantity of type required in a printing-office might be greatly diminished, and therefore the inconvenience and cost of obtaining it, if metal casts could be obtained from pages of moveable types. The type which would be sufficient for a single page, he thought, might be made to do the

work of a hundred or a thousand pages. In this manner:—the first page of the book to be printed, having been composed, a metal cast might be taken from it. Then the type might be distributed, and re-composed in the second page, from which a metal cast might also be taken; and so on in succession until the book was completed. The printer saw that the idea was good, and said if it could be put in operation, an estate might be made by the invention. Ged set to work, and, after spending two years in experiments, he succeeded in producing metal plates from moveable types in the manner already described. Ged now determined to bring stereotyping into use; but this could not be done without an outlay of money, and Ged himself was poor. He induced a gentleman, by offering him a share of the profits, to advance him the necessary funds; but the gentleman having consulted a printer, who did not understand the invention, and was prejudiced against it, he withdrew his assistance, and Ged was again foiled. In 1729, however, Ged removed to London, and Fenner, a stationer, and James, a type-founder, became his partners in the invention. The privilege of printing Bibles and Prayer-books was granted to them by the University of Cambridge. But this was the beginning of Ged's troubles, instead of success. Like as Kœnig was obstructed in the construction of the printing-machine, so Ged was obstructed

by those who thought their craft was endangered by the merit of the invention. His partner, James, supplied him with miserably shaped type to cast the metal plates from; and the workmen wilfully made errors in the pages, in order to bring discredit on the process, believing that it would diminish the demand for type and labour. The compositors, when they corrected one error, made half a dozen others, and the pressmen battered the plates, so that some parts of the printed sheets were illegible. The consequence was, that the University actually suppressed the books produced by stereotyping, so incorrectly and badly were they printed, and the plates were destroyed.

But Ged refused to succumb to this ill-treatment. He returned to Edinburgh, disappointed and depressed, indeed, but not overcome. Again he attempted to print with stereotype plates, but no compositor could be induced to set up the type from which the plates were to be cast. Ged now apprenticed his son to a printer, and the master permitted the boy to set up the types for an edition of Sallust during the night, when the workmen, enemies of stereotyping, were in their beds asleep. Ged cast the metal plates, and the book was published in 1746.

The Dutch printers, more sensible than those of England of the value of the invention, offered to purchase the right of using it.

Ged refused to sell it. They then invited him to settle in Holland, and use it himself, promising that he should be enabled to acquire a fortune. Ged refused also to do this. He was unwilling, he said, to give strangers an advantage over his countrymen. But as his countrymen would not avail themselves of his invention, and as he would not accept the offers of the Dutch, Ged struggled on in poverty until his death, which happened in 1749.

The invention lay dormant for half a century after Ged had put it in practice. In 1780, Mr. Tilloch, of Edinburgh, editor of the *Philosophical Magazine*, hit upon the same plan of printing, without having any knowledge of Ged's invention. He communicated his idea of printing from metal plates to Mr. Foulis, printer to the University of Glasgow, and they jointly produced several works printed from stereotyped plates. Mr. Tilloch was really the second inventor of stereotype printing: but he honourably admitted the superiority of Ged's exertions over his own. The knowledge of the fact that Ged had preceded him in the invention, to quote his own words, "lessened the value of the discovery so much in my estimation, that I felt but little anxiety to be known as a second inventor; and but for the persevering attempts of others to deprive Ged of the fame his memory so justly merits, and which

he dearly earned, I might still have remained silent."

Tilloch and Foulis endeavoured to make the invention profitable to themselves. They printed several books from stereotyped plates; but so great was the prejudice against this mode of printing, that they were obliged to conceal from the booksellers that the books had been printed in the new way. Stereotyping was again laid aside, after having been twice invented, and twice proved successful. What is more, attempts were made to obtain metal casts by other means. Some used matrices instead of moveable types in making the moulds; others plunged the moveable types into half-melted metal, which, of course, retained an impression when congealed: others used melted glass, sand, and other soft substances in the place of plaster. The most successful amongst the experimenters was Professor Wilson, of Glasgow, who devised a mode of multiplying engraved blocks or plates by stereotype impressions in glass and enamel, which he thought might be used for the prevention of forgery.

At length stereotyping was brought into common use by Lord Stanhope, the inventor of the Stanhope press. At the commencement of the present century his lordship received instructions from Wilson, Tilloch, and Foulis. He made a series of experiments at his country seat in Kent; and at the end of two years,

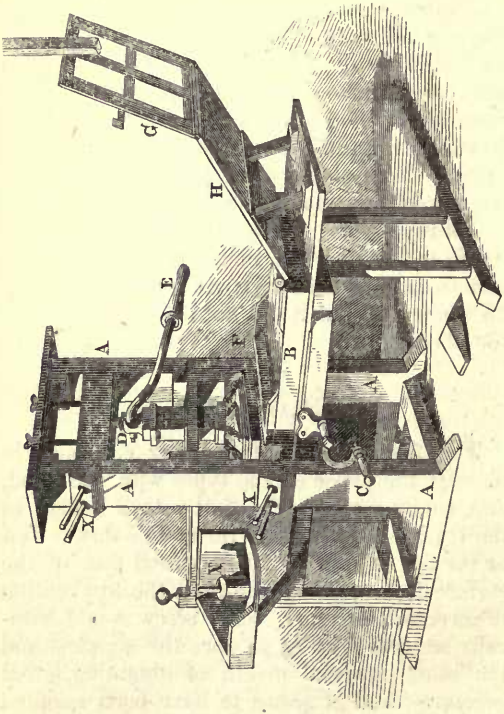
and at a cost of 800*l.*, he succeeded in producing very good metal casts from type as small as nonpareil and pearl. Professor Wilson attributes the ultimate success of stereotype printing to the genius and perseverance of Lord Stanhope, who, he says, "had overcome every difficulty, combining the most beautiful simplicity with the most desirable economy; the *ne plus ultra* of perfection, with that of cheapness." The Society of Arts, however, awarded a gold medal to Wilson, "for his great skill and exertions in stereotype printing." The best of the books printed by him was "Walker's Pronouncing Dictionary." In 1807, the process of stereotyping was adopted at the University of Cambridge, and in 1809, at the University of Oxford. All the Bibles and other standard books printed at the Universities, and elsewhere, are stereotyped; first, because it is the cheapest mode of printing books which sell largely; and secondly, because it affords security against typographical errors; for the letters cannot be displaced, as they are sometimes in printing from moveable types. If the types used in printing books of mathematics, arithmetic, dictionaries, and other works, are once composed accurately, they may be permanently preserved from errors. Stereotyping is also used in printing a book in two places at the same time. For instance, the types used in printing *Chambers' Edinburgh Jour-*

nal are composed at Edinburgh; metal casts of the pages are then taken, and while the work is printed in Edinburgh from the moveable types, it is also printed in London from these metal casts. The proprietors, instead of sending several thousand printed copies of the work to London every week, send the metal casts of the pages from which the copies required in England are printed. The cost of casting these plates is considerably less than the amount which must otherwise be expended in conveying the printed copies from Edinburgh to London. A method of casting from moulds made with paper was introduced about 25 years ago, but it did not answer so well as the plaster.

The Printing Press.

The first method of printing consisted in placing the paper on the types with the hand, and rubbing the back of it with a brush, as the Chinese continue to do at this day. But as the art advanced, the increased size of the surface to be printed, required the application of increased pressure. The screw would naturally suggest itself as at once the simplest and the most powerful means of obtaining great pressure: and it seems to have been adopted at the earliest period in the history of printing. The first press resembled the linen press, the cider press, and the other screw presses of the

present day. It consisted of a board on which the type to be printed was placed; a sheet of



First Printing Press.

paper having been laid on the inked type, the board was rolled, by means of a handle under

another board, attached to a screw fixed in a frame. The screw was then turned round by a handle, the board at the end of it was thereby pressed down on the paper and the types, and the impression was given. The preceding cut of an old press will convey a general idea of all the different presses that were made until a comparatively recent period; for although there may have been differences in the details, there were none in the principle.

A A is the framework supporting the press. B is the board or table on which the types are placed to be printed. C is the handle by which the table is rolled in, to receive the pressure; the table stands on runners not unlike a railway, which cannot be shown in the engraving. D is the screw, E the handle, and F the platen, by which the pressure is given. G is the frisket, an iron frame covered with paper, which in the engraving has been cut into four holes for the printing of four pages of type, and H is the tympan, consisting of a fine blanket laid between two skins of parchment, which are stretched on a square iron framework.

The press is worked in this way. The type to be printed is laid on the table, and inked with a soft roller, made principally of boiled glue and treacle. The printer lays a sheet of paper on the tympan, and turns down the frisket upon it. The object of the frisket is to keep the paper from falling off the tympan, and to prevent any part of it, except those

parts which are to be printed on, from being inked, or, in other words, to keep that part of the sheet which is to form the margin, from getting soiled. After laying on the sheet, and turning the frisket down upon it, the printer doubles the tympan and frisket together, and turns them down upon the types, and then, turning the handle, he rolls the whole carriage, as it is called, under the platen. The bar is then pulled, the screw is thus turned round, and pressing down the platen the printing of the sheet is effected. The bar is then suffered to resume its former place, the screw thereby lifts the platen, the printer rolls out the carriage, unfolds the tympan and frisket, and removes the printed sheet.

The first improvement in the printing-press was made in the year 1620, by Blaen, or Blew, a Dutchman. He had been apprenticed to a joiner, and afterwards rambled into Denmark, where he was entertained by the celebrated astronomer Tycho Brahe. Brahe employed him to make astronomical instruments, and compensated his services by teaching him how to make a globe. On returning home, Blaen became a dealer in books and maps, many of the last of which were engraved by himself. Afterwards, he set up as a printer; and discovering the defects of the printing-press, he made a new one, in which those defects were remedied. He was so pleased with his success, that he made nine of the new presses at one

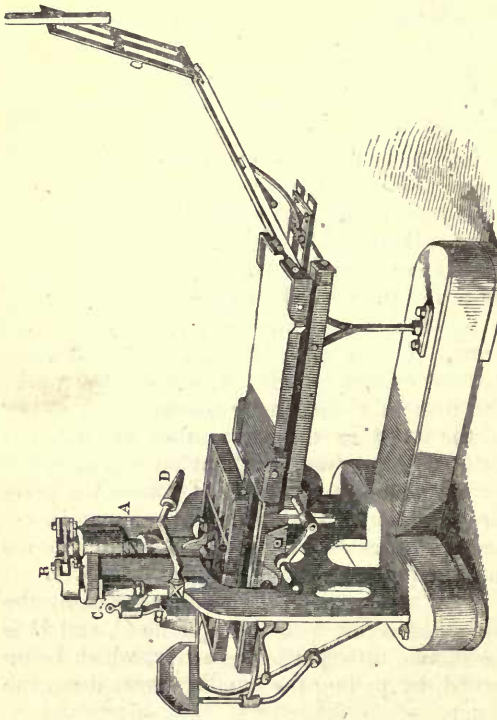
time, and called them the Nine Muses. This was the press in use until the commencement of the present century, and it is occasionally found standing, and even in use, in printing offices at the present time.

Blaen's press was superseded by the Stanhope press, so called after Lord Stanhope, the inventor of it. His improvement consists in giving to the handle the power of a bent lever. The handle of the press previously used was fixed on the screw by which the pressure was given. Instead of this arrangement, Lord Stanhope succeeded in connecting the top of the screw by a short lever and a link, to the top of a spindle placed parallel to the screw. The handle of the press is attached to the end of this spindle; and when the workman first pulls the handle towards him, owing to the position the levers then occupy, the platen descends very fast, but on reaching the surface of the type, where, of course, the pressure is required, the levers have changed their position in such a manner that the platen moves more slowly but with much greater power.

A is the screw; B the levers connecting the top of the screw with the spindle C, and D is the handle attached to the screw, which being turned, by pulling the handle, forces down the platen.

The advantage arising from this arrangement of levers is, that platens twice as large as those previously used can be worked with

far less strength. The platen of the old press was only half the size of the sheet of paper



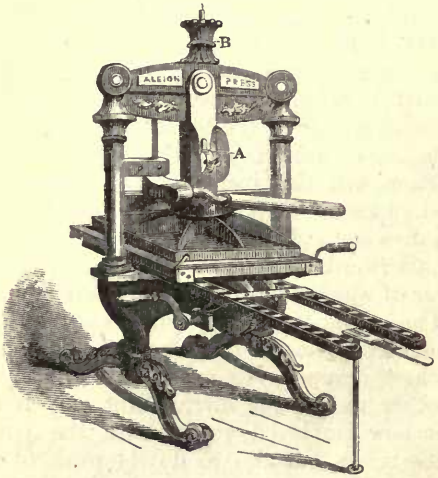
Stanhope Press.

on which books are usually printed, as may be seen by comparing the cuts; and in con-

sequence it was necessary to roll half the table under the platen, pull the handle, and print half the sheet, then roll the other half of the table under the platen, and pull the handle again before the whole of the sheet was printed. Lord Stanhope's press, however, admits of platens being made sufficiently large to cover the whole of the sheet at one time, while the bent lever handle enables the pull to be effected with great ease. Furthermore, the increased power of the Stanhope press allows of the use of iron, instead of wood, in its construction, and this increases its efficiency, as wood yields to the power of the screw, while iron does not. Lord Stanhope's improvement was afterwards applied to wooden presses, the power of which was greatly increased by it.

The Stanhope press suggested a still greater improvement of the press. The screw which it retained, was superseded entirely by a further use of the lever. Not only is the lever now employed to increase the power of the screw, but also to do the work of the screw. There are now several kinds of presses; but though they differ in the details of their construction, they are exactly alike in using the lever to produce the impression, instead of the screw. The screw, indeed, is no longer used. The lever is, however, applied in many different ways. In the Albion press, for instance, two wedges or levers are placed within A, and when the press is idle, they lie together

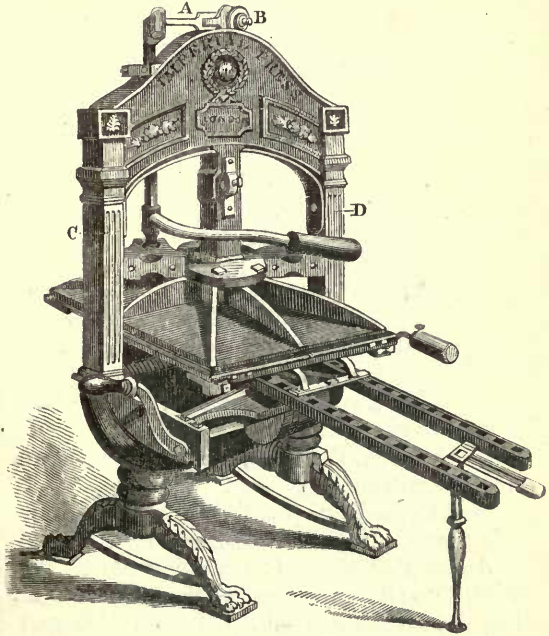
something like the letter ⊱; by pulling the bar-handle, they are straightened like the knee on rising from a sitting position, and by their greater length force down the platen upon the type and thus produce the impression.



Albion Press.

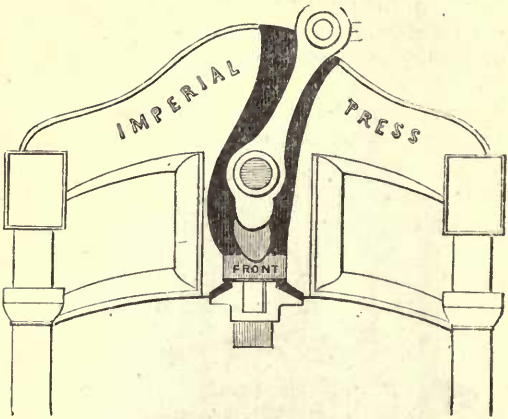
On the return of the bar-handle to its place of rest, the platen is lifted from the face of the type by means of a spiral spring fixed in the box B, and the two levers fall into the shape of a ⊱ again. The press, and those succeeding it, are shown with the tables rolled in under the platen.

The principle of the Albion press, though not the precise mode, is shown in the Imperial, which is an improvement upon it.



Imperial Press.

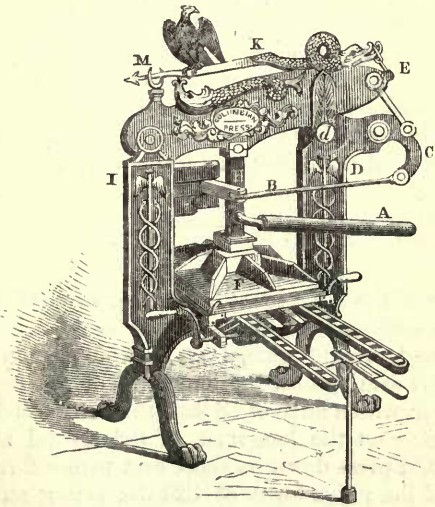
The bar-handle being pulled over, the levers A, straighten the lever B, which fills a hole in the frame of the press thus :—



The straightening of this lever forces the platen down upon the face of the type. The platen is lifted again on the return of the bar-handle by two springs attached to the inside of the cheeks of the press, C D, but not shown in the engraving.

The Columbian press is worked entirely with levers. The bar A being pulled, the rod B draws the elbow C inwards towards the cheek D, and thereby pulls down the head E. The head is not a fixed and immoveable part of the frame, as in other presses, but is a large lever, its fulcrum being the cheek I. The platen F is attached to the head by an iron bar H, and when the head is pulled down, the platen beneath this bar is forced down

upon the face of the type. There is another lever, K, attached to the head bearing the eagle above it. The head in descending pulls downward the short arm of this lever as the head rests on a fulcrum formed by the cheek D at *d*, and, in consequence, the opposite end, that is, M, bearing the eagle, is lifted upwards; this in falling draws the bar-handle back to its place of rest, lifts the platen, and raises the head.



Columbian Press.

The principle and action of the Columbian press will not be thoroughly appreciated, unless the principle and action of the compound

lever are understood. For it is really nothing but a compound lever applied to printing; and, indeed, this may be said also of the Albion and Imperial presses, though they do not exhibit it so fully and clearly. It is known to every schoolboy, that an ounce weight placed on one end of a lever, may be made to balance a pound placed at the other end of the lever, simply by lengthening the distance of the small weight, and shortening the distance of the large weight, from the fulcrum or point on which the lever rests. But the power of the lever may be enormously increased by using a number of levers in connection with each other. For instance, let it be supposed that the three levers here delineated

are of the same length, the long arms of each 18 inches, and the short arms 1 inch. A pound weight placed at A would press the short arm against the long arm of the second lever, with a force of 18 lbs.; this force of 18 lbs. acting on the long arm of the second lever, would press down its short arm with a force of 324 lbs.; this force of 324 lbs. acting on the long arm of the third lever, would force up the short arm with a force of 5832 lbs.! The rule is to multiply the weight by the length of the long arm of the lever, and the product is the

force it exerts on the short arm. For the sake of clearness we will give the result in a sum :—

	lbs.
The weight on the long arm of the first lever - - - - - -	1
Multiplied by the length of the lever - - - - - - - - -	18
The power with which the long end of the second lever will be forced up.	18
This multiplied by the length of the second lever - - - - -	18
	144
	18
The power with which the long arm of the second lever will be forced down.	324
This multiplied by the length of the third lever - - - - -	18
	2592
	324
The weight which 1 lb. on the first lever will balance on the third lever.	5832

The levers by which the power of the Columbian press is obtained are much longer than those which we have just described, and

consequently the force which they exert on the surface of the type is much greater. The length and number of the levers employed enable the pressman, by a gentle pull at the bar-handle, to give a severe pressure to the platen.

The Printing Machine.

A marvellous change has been effected in the art by the invention of the Printing Machine. The press is defective in two essential points. It is very slow, and great strength is required in working it. Only two men can work at it together, and these two cannot print more than 250 impressions an hour of what is now a small-sized sheet, that is, 2500 impressions a day, on one side of the paper only. No man is strong enough to give the pressure required in printing some of the large sheets, such as those on which the newspapers have been printed since the invention of the machine. The machine excels in those points in which the press is defective. It prints swiftly, and it gives an enormous pressure. Instead of 250 small sheets an hour being the highest rate of printing, no less than 60 gigantic sheets are printed in a minute!

This has been effected by substituting a cylinder, or round iron roller, for the platen or flat surface. The pressure, instead of being obtained by forcing a flat surface down upon the face of the type, is obtained by rolling a

roller over the face of the type. Again, instead of the motion being given by the strength of a man, it is now given by a steam engine. The result is, that there is really no limit to the speed of printing. The faster the machine can be fed with sheets to be printed, the faster it may be worked. It has been ascertained that a man can place 1250 sheets an hour on the feeder of the printing cylinder. If, then, the feeders are increased in number, the printing may in the same proportion be increased in rapidity.

The printing machine originated with Mr. Nicholson. But he rarely obtains any credit for it, and though he suggested the principle, and even sketched the plan, he did not put it in practice. In April 1790, Mr. Nicholson obtained a patent for a printing machine; and the specification or description of it, deposited by him at the office of patents, states that he proposed to substitute a cylinder for a platen, or, to use other words, rolling for squeezing. Nay, more; the excessive speed required to print the vast number of copies issued daily from the London newspaper offices, has led to the construction of upright cylinder machines, in which the type, instead of being laid flat under the cylinder, is fixed round the surface of the cylinder itself. This improvement was considered as a triumph of the art when effected by Mr. Augustus Applegath in 1848; yet even this is described

in Nicholson's specification. Mr. Nicholson, as we have already said, never succeeded in constructing a printing machine. The cause of his failure is, perhaps, explained in the remarks which he published on "The Art of Printing Books." He had not only to overcome the inherent difficulties of making a new machine, but he was cramped in his experiments by want of money. Few men possessed of independent fortunes, he says truly enough, are likely to trouble themselves with labour of this kind; whilst it almost invariably happens that the expense exceeds the means of the inventor, who is usually a poor person stimulated by a desire to make a fortune. Nicholson seems to have had no rich friends willing to encourage or reap the benefit of his mechanical abilities. Then he was opposed by the manufacturers of the press, whose craft was endangered, and also by the prejudices of the printers in favour of the old mode of working. Moreover, he was actively engaged in writing books; he kept a large school; and he was agent for Lord Camelford. If he had possessed money, he would have had no time to spend in carrying out his idea of a printing machine.

What Mr. Nicholson left undone M. Kœnig, a Saxon, accomplished. Kœnig was a printer by trade, and had endeavoured to make the common press work faster by applying steam to it. But neither Saxony nor

any other continental country in his day gave much encouragement to the mechanical arts. Kœnig, with his head full of ideas on the subject, came to England, which was then almost the sole workshop of the world. Reaching London in 1804, he laid his plans before several printers of repute. But they gave him a very cold reception. Either they thought him a visionary, or they did not like to risk their money in experiments for the improvement of their art. The press, in truth, moved fast enough for the work to be done. Besides, at that time Kœnig had really invented nothing, though he conceived it possible that something might be invented. Fortunately he attracted the attention of a great printer, Mr. Bensley, and suggested to him that the press might be moved quicker, while the second man employed in inking the types, might be superseded by self-acting rollers.* Mr. Bensley, being a practical and enterprising man, succeeded in drawing Mr. Woodfall and Mr. R. Taylor into the speculation, and they supplied Kœnig with money to carry on the necessary experiments. But he failed so completely, that Mr. Woodfall gave up the attempt in despair. Mr. Bensley and Mr. Taylor were, however, more sanguine, and they went on, year after year, supplying Kœnig with funds to overcome the unforeseen

* A press was made about the year 1800, by the late Lord Stanhope, that had inking rollers attached to it, and was worked a short time at the Shakespeare Printing-office.

difficulties which constantly rose in his way. At length Kœnig himself fairly confessed that he was unable to reduce his ideas to practice. Simple as they might seem in theory, they were impossible in fact; and after much time and money had been wasted, it was clearly proved that the intended improvement could not be brought to bear with the common press. Kœnig now turned his attention to cylinder printing. The idea had probably been suggested to him by the patent granted to Mr. Nicholson; for he had come to England for the purpose of applying steam to common presses, not to make cylinder machines. Bensley and Taylor still supplied him with money, but three years passed with a similar want of success. At length, after many failures and disappointments, these gentlemen were richly rewarded for their enterprise. Kœnig, though he had long been foiled, succeeded in constructing a cylinder machine that actually would work. The types were inked by the machine, and the paper was printed by being passed under a roller. The machine was first set in operation at the manufactory in Whitecross-street, in April 1811, and printed 3000 sheets of the *Annual Register*, to the admiration of all persons who beheld it at work. It was, however, a very costly triumph. For in the seven years of experimenting, which it had required to bring Kœnig's ideas to bear, Mr. Bensley spent no less a sum than 16,000*l.*

At this period *The Times* newspaper was in existence, though it had not then become what it is now, the first journal in the world. The publication of *The Times* had been commenced on the 1st of January, 1788, and it was a continuation of the *Daily Universal Register*, the first number of which had been issued exactly three years previously. Both these journals were "printed logographically," as it was styled, that is to say, the types did not consist of single letters; but syllables, whole words, and even phrases were cast in a piece. Mr. Walter, the proprietor of the papers, had taken out a patent for this kind of printing, in the idea that it would effect a saving both of time and labour, and consequently of expense. Out of the 90,000 words which the English language contains, he had ascertained that only 5000 were in general use, and furthermore, that a great many of these had the same root, or to use more familiar words, were the same in body, though differing in the head and tail. Take the word USE for an example. Use becomes *dis*use, *mis*use, use*ful*, use*less*, use*fulness*, use*lessness*.

The system provoked much ridicule amongst the printers. It was said, for instance, that when Mr. Walter gave an order for type to the type-founders, he would say or write in some such terms as these: "Send me a hundred-weight of logographic type, viz., 10 lbs. of

heat, 10 lbs. of *cold*, 10 lbs. of *murder*, 20 lbs. of *dreadful robbery*, 5 lbs. of *atrocious outrage*, 5 lbs. of *fatal accident*, 10 lbs. of *terrible explosion*, 10 lbs. of *fire*, 10 lbs. of *wet*, and 10 lbs. of *dry*. Also one hundred pounds made up in equal portions of *honourable gentleman*, *interesting female*, *loud cheers*, *beauty and fashion*." But ridicule was not the worst evil that Mr. Walter encountered. It was found that the experience of logographic printing was just the reverse of what had been expected. Instead of saving, it wasted time and labour. Time was, indeed, saved in having words in a piece, instead of composing them in separate letters; in being, for instance, able to take up "and the," or any other phrase at once, instead of by six motions of the hand; but then much more time was lost in running to and fro, to reach the place in which the words were kept. The ordinary pair of letter cases contains 151 boxes, which hold all the different letters used in printing, separated from each other, the a's being by themselves, the b's by themselves, and so on throughout the alphabet; and the compositor, without moving from the spot on which he stands, can reach every box with ease. But the cases in which the types of logographical printing were placed, contained some hundreds of boxes; the cases themselves were four in number instead of two, and they were so enormously large that the compositor had to

walk backward and forward to get the sorts he wanted next. Mr. Walter ultimately abandoned the system as impracticable, but not before he had spent all his fortune.

Mr. Walter gave the following amusing account of his reasons for changing the name of his paper from "*Daily Universal Register*" to "*The Times*:"—

"*The Universal Register*, from the day of its first appearance to the day of its confirmation has, like Tristram, suffered from unusual calamities both laughable and serious, arising from its name, which, on its introduction, was immediately curtailed of its fair proportion, by all who called for it, the word *Universal* being *universally* omitted, and the word *Register* being only retained. 'Boy, bring me the *Register*.' The waiter answers 'Sir, we have not a library, but you may see it at the New Exchange Coffee House.' 'Then I'll go see it there,' answers the disappointed politician, and he goes to the New Exchange, and calls for the *Register;* upon which the waiter tells him he cannot have it, as he is not a subscriber, and presents him with the *Court* and *City Register;* the *Old Annual Register*, or the *New Annual Register*. For these and other reasons the parents of the *Universal Register* have added to its original name that of THE TIMES; which, being a monosyllable, bids defiance to corruptors and mutilators of the language."

There is, then, something in a name after all. But it was not until *The Times* came into the hands of Mr. Walter's son, that it began to rise to a greater importance than the other London journals. The earliness and accuracy of its intelligence largely increased its circulation; Mr. Walter having arranged a system by which he procured accounts of events abroad, even before the government of this country was acquainted with them. For instance, *The Times* announced the capture of Flushing forty-eight hours before the news reached the English ministers, by whose orders it had been attacked. Mr. Walter was equally successful in obtaining clever writers for *The Times*. To effect this he encouraged "Letters to the Editor," and whenever he found a communication of talent, he sought out the writer, and employed him to write articles on any subject with which that writer was well acquainted. In this way he contrived that the articles of *The Times* should be the best productions of men competent to write on each particular subject. In consequence, the character of the journal grew so high, that the demand for it could not be supplied with the common press. But this was a pleasant difficulty, compared with another with which Mr. Walter had to contend. The printers continually took advantage of the great sale of *The Times* to make him pay exorbitant wages. At this time the experi-

ments for the construction of a printing machine were going on; and as his men would not act fairly, Mr. Walter determined, if possible, to do without them. The idea appeared as ridiculous to ordinary minds as it once did to propel a ship fifteen miles an hour without sails, or to drag a train of carriages, weighing a hundred tons without horses, fifty miles in as many minutes. Mr. Walter was, however, not to be discouraged by difficulties.

This was in the year 1804. At that time Mr. Walter had a young man named Thomas Martyn, in his employ as a compositor. Struck by the difficulty experienced in printing *The Times* fast enough for the customers, Martyn tried to devise the means of quickening the press. He succeeded at last in contriving a self-acting machine for working it. Mr. Walter, on being shown the model, saw at once that the thing was practicable; and supplied Martyn with money to complete the work. But the news got abroad amongst the printers that Martyn had invented a machine which would work itself, and the pressmen, fearing that it would take away their employment, vowed vengeance against him. In truth, he went in danger of his life. He was obliged to wear all sorts of strange disguises that he might escape their notice and fury. As for the machinery he was forced to introduce it bit by bit into the printing office at night, or by day, pretending it was something else; for the

pressmen only wanted the opportunity to break his contrivance. The machine was nearly completed; little remained apparently to render it efficient, when Mr. Walter's money became exhausted. His father had also become disheartened by delay, and refused to lend him any further assistance. The experiment was therefore abandoned, and this, too, apparently almost on the eve of success.

But Mr. Walter did not despair. He continually thought on the subject, he employed others to think on it, and was, in truth, determined to try again whenever he might have the money. Ten years afterwards, in the year 1814, he recommenced the attempt. In the interim, Kœnig had constructed the printing machine already described for Mr. Bensley, and Mr. Walter employed him, with his friend Bauer, to construct a machine of the same kind sufficiently large and powerful to print *The Times*. Bensley's machine was cumbrous, complicated, and uncertain in its operations, and, therefore, unfit for the work of a newspaper, in the printing of which certainty is of as much importance as speed. Mr. Walter munificently supplied the two artizans with the means of effecting some improvements which had occurred to them, and of making sure that the machine could do its work with regularity. But they dared not venture into the printing-office of *The Times*, for the pressmen still threatened "destruction to all such inventors and their

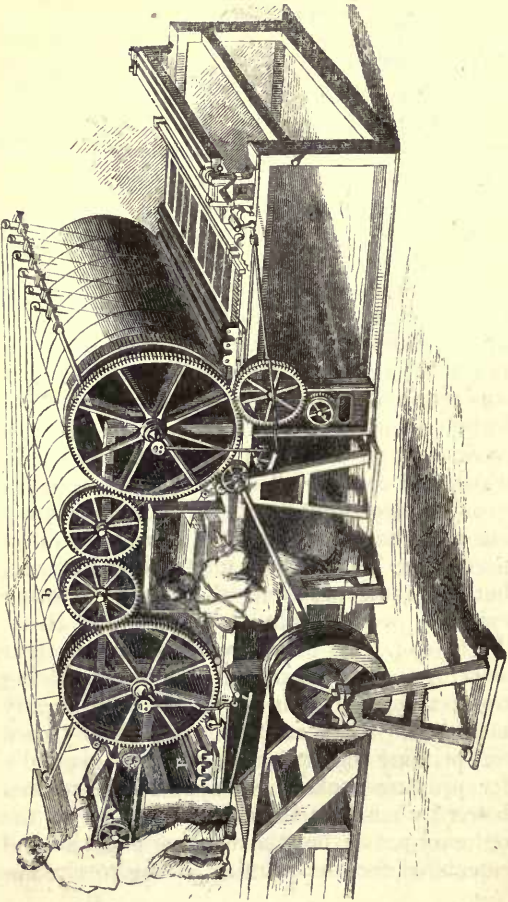
traps." The adjoining premises were therefore engaged, and here for a long time they toiled secretly and safely. But it was weary work. The mechanical contrivance which would overcome one difficulty, only raised up another. The combinations methodically arranged in the mind of the inventor, could not be put into working trim. Still the machine advanced towards success; the mechanists were almost "in sight of land," when a difficulty arose which, after repeated trials, they concluded was insurmountable. They slunk from the premises in despair and disgust. Brindley, the great engineer, would have gone to bed, and remained there until he had hit upon some plan of curing the defect. Kœnig and Bauer, however, considered themselves completely beaten, and entirely disappeared, no one knew whither. Great was the disappointment of Mr. Walter with their failure, and great also was his consternation at their disappearance. But at the end of three days a clergyman, whom Mr. Walter had consulted continually during the work, discovered where the fugitives had hidden themselves to conceal their mortification. He induced them to return to their work, and he luckily saw how they might conquer the difficulty which had dismayed them. Like geniuses as they were, they were carried by this success from the lowest depth of despondency to the highest pitch of hope; the machine was completed, and during the

night of November 19, 1814, *The Times* was printed by it.

"Our journal of this day," said *The Times* on the following morning, "presents to the public the practical result of the greatest improvement connected with printing since the discovery of the art itself. The reader of this paragraph now holds in his hand one of the many thousand impressions of *The Times* newspaper which were taken off last night by mechanical apparatus. A system of machinery, almost organic, has been devised and arranged, which, while it relieves the human frame of its most laborious efforts in printing, far exceeds all human powers in rapidity and despatch. That the magnitude of the invention may be justly appreciated by its effects, we shall inform the public that, after the letters are placed by the compositors, and enclosed in what is called the form, little more remains for man to do than to attend upon and watch this unconscious agent in its operations. The machine is then merely supplied with paper—itself places the form, inks it, adjusts the paper to the form newly inked, stamps the sheet, and gives it forth to the hands of the attendant, at the same time withdrawing the form for a fresh coat of ink, which itself again distributes to meet the ensuing sheet, now advancing for impression; and the whole of these complicated acts are performed with such a velocity and simultaneousness of move-

ment that no less than 1100 sheets are impressed in an hour."

Success as usual followed on success. The machine just described printed only one side of the paper at a time; another was soon constructed which printed both sides before the sheet left the machine. This is what is called the perfecting machine. But these machines were complicated and liable to get out of order. The principle having been put in practice, the engineers set about simplifying the invention. In this they triumphed over all difficulties. The original machine contained no less than 100 wheels; the number was reduced to 10. Mr. Edward Cowper, for instance, on seeing *The Times* machine at work, suggested a slight alteration, and wheels which had cost 1,500*l.* during the experiments, were at once swept away. Gradually printing machines have been brought to a high state of perfection. They exhibit many different forms, but the same principle, that of the printing cylinder, pervades almost the whole of them. Their cost has been greatly reduced, their working rendered sure and safe, by simplifying the details, and their speed has been greatly increased. They are almost universally used for printing newspapers and very generally for printing books. Newspapers are printed better by machine than they could be by the ordinary press; but the machine is not so well calculated for fine printing, owing to circum-

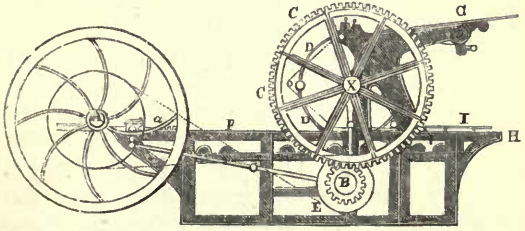


Applegath and Cowper's Machine.

stances which only a practical printer can understand. For this reason the most beautiful books are printed by the common press; but very good work is done by the *platen* machine.

The printing machines in general use may be divided into two classes, viz.:—Single-cylinder machines, which print one side of the sheet; and double-cylinder machines which print both sides of the sheet before it leaves the machine. A double cylinder machine may be compared to a couple of single-cylinder machines thrown into one.

The following is a skeleton or linear representation of a single-cylinder machine, with the omission of minor details for the sake of clearness:—



It is necessary first to describe how the different parts of the machine are set in motion at the same time, and at the same speed, though some of them move in different directions, and even change their directions. If the machine is to be worked by men, a handle

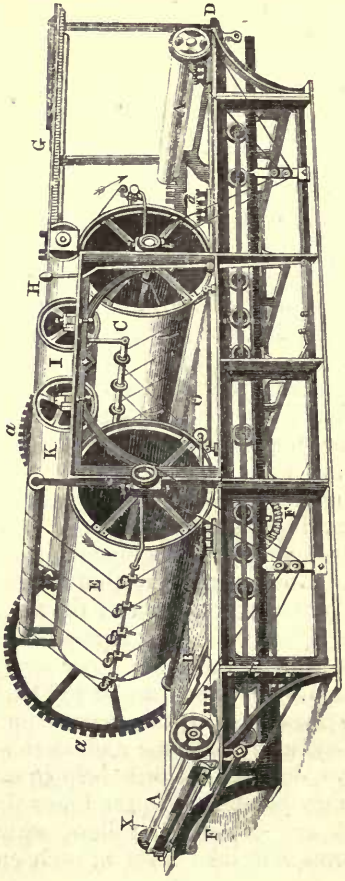
is inserted in the axis of the large wheel A: if it is to be worked by steam, then the wheel is replaced by another, connected by a band, as shown in page 110, with the shaft of a steam-engine. The wheel A being turned round, the cord, shown by the dotted lines, turns the cogged wheel B; this wheel works in the cogs of a larger wheel C, and C turns the printing cylinder D behind, the two latter working on the same axis X. The little cogged wheel also turns a universal wheel, the place of which is indicated by the shading E, a part of the machinery on which it works, and the universal wheel sets in motion the table of the machine on which the form of type is placed. This table moves backward and forward within the framework F, F, on the little wheels beneath it. The printing is a very simple process. The sheets to be printed are placed on the board G; a man standing on a platform, as shown in Bensley's machine (p. 110), moves sheet after sheet down to the top of the printing cylinder D, when it is caught by a cleverly contrived apparatus acting like the human hand, and is drawn within the tapes which go round the cylinder, as shown by the dotted line. When the printing cylinder begins to turn, the table also starts from the end at which the large wheel A is placed; the form inks itself by passing under the rollers indicated by *a*, and then slides towards the printing cylinder D: the form reaches the

printing cylinder exactly when the latter has brought the edge of the sheet to the same point; and the sheet is printed by being pressed between the surface of the cylinder and the type, as they move towards the end of the machine H. The tapes, which have kept the sheet close to the surface of the printing cylinder, it will be seen, are not continued round the cylinder, but end under it. Thus, the printed sheet is not carried upwards as the cylinder moves upwards, but is thrown off on the board I, and the form passes under the board. While that part of the cylinder on which the grippers are placed is rising to roll round another sheet, the table has shot back to the opposite end of the machine, the form obtains another supply of ink, and shoots back again, reaching the printing cylinder the very instant that it has brought down another sheet to be printed, as already described. This ingenious motion, forward and backward, is caused by the working of the universal wheel under the table.

The following is a representation of a double-cylinder machine. (*See next page.*)

The moving-wheels are at the back instead of the front, as in the representation of a single-cylinder machine; and, as this is a perspective drawing, it will help to make clear what may be obscure in the linear drawing.

A A are the inking-rollers, which supply the forms with ink; a set at each end of the


D
G
H
C
I
a
K
E
F
a
A
X
F

machine, outside the large printing cylinders. The type is inked by the rollers *a a*. B is the form of type for printing one side of the sheet: the second form, for printing the second side, cannot be shown, as when one form is drawn out in the position of B, the other is drawn under the cylinder C. The forms glide backward and forward, B under cylinder E, and the other form under cylinder C, on a table similar to the table of the common press, the table being set in motion by a wheel F. The moving machinery is indicated by the cog-wheels *a a*. A man stands on a platform with the sheets to be printed lying on a board G; he moves sheet after sheet downwards, until its edge meets the roller H, the end of which is just seen, and the sheet is caught within a series of endless tapes, which are shown by dotted lines extending throughout the machine, but they are too complicated to be clearly explained in words. These tapes, in moving in common with the machinery, carry the sheet in the direction of the downward arrow round the first printing cylinder C, and by the time that the sheet is half round, the bed of the machine has moved sufficiently to place the type under the cylinder C, and the cylinder and type move together in the direction of O, so that the first side of the paper is printed as it passes between them. The paper is now carried by the tapes upwards, over the cylinder I, and passing under

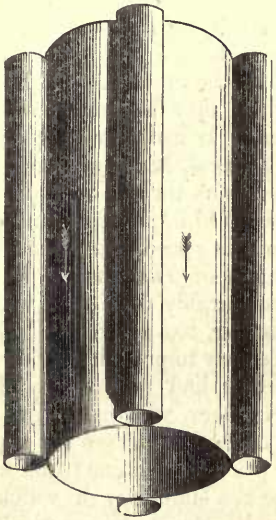
the cylinder K, is carried round the outside of the second printing cylinder E. By the time the paper is half round again, the second set of types has arrived under the cylinder E, and thus the second side of the paper is printed as it passes along between them. The sheet being thus perfected, is thrown out at O, where a boy sits to receive it. The object of the cylinders I and K is simply to convey the sheet smoothly from one printing cylinder to another. But how, it may be asked, is the sheet turned while it is passing through the machine to allow of its being printed on both sides?—By making the printing cylinders turn in opposite directions, and thereby passing the sheet down the outsides of them. If the sheet passed down the inside of the second cylinder E, the printed side would be presented to the second form of type: but by passing it outside, the paper is really reversed, and the unprinted side is presented to the type. It is difficult to explain this in words; but any one may see it clearly by taking a piece of paper and passing it over two rollers which are moving in different directions, in a similar manner to the printing cylinders. The printing machine exhibits some other beautiful contrivances for the regulation of its working; but it would be impossible to represent them in an engraving, and they must be seen to be understood.

The speed of a single-cylinder machine is,

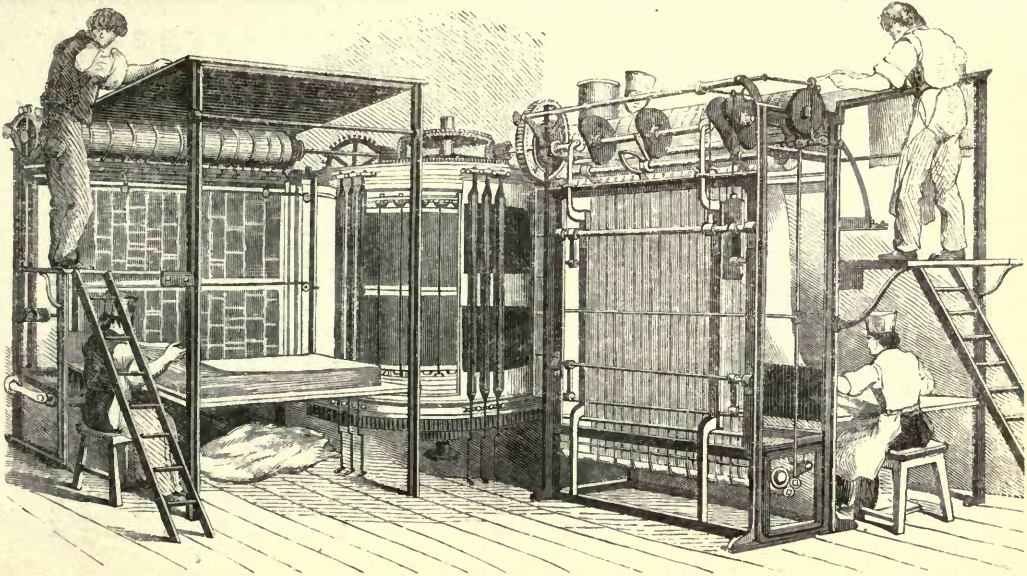
on the average, about 1000 sheets an hour, and of a double cylinder machine about 750 sheets an hour printed on both sides. The speed, as we have said, is limited by the power of feeding the machine with paper, and few men can lay on more than 1250 sheets an hour. But a far greater speed has been attained by increasing the number of cylinders. For instance, Messrs. Applegath and Cowper constructed for the proprietors of *The Times*, a machine which may be considered four machines in one. It had four printing cylinders, four feeding places, and four places where the printed sheet was thrown out, and the speed attained was 4000 impressions an hour.

But even this speed has been outstripped. The circulation of *The Times*, the name of which is inseparably connected with the progress of printing, has grown so large, that it became necessary to print it quicker than ever. The proprietors had recourse to Mr. Applegath, an engineer, who had previously done more than any other person for the improvement of the printing machine; and he has constructed one the simplicity of which is admirable, while its speed is practically without limit. It is a cylinder machine, but instead of the cylinders being placed horizontally as in the machine already described, they are placed vertically, that is, like a drum standing on one end. The type is also fixed on the surface of the central cylinder, which turns round continuously

instead of being placed on a bed or table, moving backward and forward under the printing cylinders. Before we proceed to give a particular description of this wonderful machine, we may perhaps be able to convey a rough idea of it by the following diagram.



These cylinders represent the cylinders of the machine. It must be borne in mind that they stand upright like so many columns, the opposite ends pointing towards the ground. The types to be printed are fastened on the surface of the central cylinder A, and the



whole of the cylinders turn round in the same direction. The small cylinders are really the printing cylinders. A sheet is put in at each of the places marked by the arrow, it is drawn in by the motion of the machine and pressed against the large drum, and thrown out on the other side printed. Of course, it is so arranged that the type on the great cylinder shall arrive opposite each small cylinder at the instant that it is fed with a sheet of paper.

What we have just written simply illustrates the principle of the new printing machine. We will now endeavour to convey an idea of its details, taking for our example the superb machine by which *The Times* newspaper is printed. A large central cylinder or drum is erected, capable of being turned round on its axis. Upon the sides of this drum are fixed the columns of type by which the newspaper is printed, running straight up and down. The drum is 200 inches in circumference and 66 inches in diameter, and, therefore, the curve formed by its surface is so easy that the types stand almost square on their feet, just as men do on the round earth. The great drum is surrounded with eight smaller drums or rollers, also placed with the axis vertical, that is, like so many columns standing upright. Each of these cylinders is connected with the great drum by toothed wheels, in such a manner that their surfaces must move at exactly the same

rate as the surface of the drum. They are, in other words, so connected, that they can only move together and at the same speed. The printing is effected in this way. The drum and cylinders are set in motion; and in moving, the types on the surface of the drum become inked, and the eight cylinders are supplied with paper. The drum in passing round presses the type successively against each of the eight cylinders, and thus in turning round once eight sheets are printed.

Let us now explain how the type is inked eight times whilst the drum is turning round once; and how the eight cylinders are supplied with paper. Beside each of the eight paper cylinders are placed a set of inking rollers; near these are placed two ductor rollers. These ductor rollers receive a coating of ink from reservoirs placed above them. An inking table is attached to the great drum, and as it passes, receives a coating of ink from each of these rollers. The inking table next meets the rollers which ink the type, and transfers the coating of ink to them. Next, the types pass along, and encountering the inking rollers, receive the ink in turn. Next, the types encounter the paper on the cylinders, and thus they are printed. In a single revolution of the great central drum, therefore, the inking table receives a supply twice successively from the ductor rollers, delivers over that supply eight times successively to the inking rollers,

which in their turn deliver it eight times successively to the faces of the type, from which it is conveyed finally to the eight sheets of paper upon the eight cylinders.

It remains to be explained how the eight cylinders are supplied with paper. Over each of them is erected a sloping desk, upon which a stock of unprinted paper is placed. An attendant standing by the side of the desk, pushes the paper, sheet by sheet, towards an apparatus known as the fingers of the drum. These fingers seizing the sheet by the edge, draw it straight down in a line with the drum, just as we draw down a window blind, and when it has descended sufficiently, a self-acting frame moves it sideways instead of downwards, and it is carried between tapes towards the printing-cylinder. As it passes round the printing-cylinder the types have been moved round sufficiently to print it. The sheet is then carried back, still sideways, by the same tapes on the other side of the frame, until it arrives at another desk upon which it is received by another attendant. It may be stated here that one of the difficulties which Mr. Applegath had to encounter in the construction of this vast piece of machinery was so to regulate the self-acting machine that the impression of the type should always be made in the centre of the page, and so that the print on one side of the paper might come exactly back to back with the print on the

other side. This is generally accomplished, though an occasional deviation will occur. The type fixed on the drum moves round at the rate of five feet per second, and the paper to be printed is moved in contact with it, of course, at exactly the same rate. Now, if by any error in the placing of a sheet of paper, or in its motion, it should arrive at the printing cylinder so little as 1-60th part of a second too soon or too late, that is, before or after the type has arrived opposite the printing cylinder, each column will be printed one 1-60th part of five feet out of its place, that is to say, one inch. In that case the edge of the print on one side of the sheet would be an inch nearer to the edge of the paper than the print on the other side. Such an incident rarely happens, but when it does the sheet is spoiled. Still the waste from the slipping of the sheets is considerably greater in the horizontal machine, than in the present vertical machine.

The movement of the vertical machine is round and round again without interruption. *The Times* machine prints no less than eight sheets at every revolution. The moment that one sheet is drawn into the machine, space is left for another, which the attendant immediately supplies, and in this manner the machine receives from him two sheets in every five seconds. As the same thing takes place at each of the eight cylinders, 16 sheets are

drawn into the machine and printed every five seconds. *The Times* machine prints between 10,000 and 11,000 sheets an hour with ease; but if the men who place the sheets are very expert, it will work off from 12,000 to 13,000 an hour. Indeed, the rapidity of the machine is limited only by the power of the men to feed it with paper. If still greater speed were required, it might be obtained without changing the principle of the machine. It would only be necessary to increase the size of the great central drum carrying the type, so that a larger number of printing cylinders might be placed round it. If, for instance, a machine with eight cylinders will print 10,000 sheets an hour, a machine with sixteen cylinders would print 20,000 an hour.

The benefit arising from the machine printing is incalculable. The machine has relieved men of hard toil which was often hurtful to health. Sheets of a greatly increased size can now be printed. The cost of printing has been greatly reduced, and the employment of printers greatly increased. The result has been an extraordinary diffusion of all kinds of knowledge, and a great advance in the civilization of the world.

The Printing Office.

We have now described the rise and progress of Printing, the manufacture of type, the

construction of the press and machine, and, in short, the apparatus by which the art is practised. We proceed to describe the printing of a book; and in doing this we shall conduct our readers through a printing-office, whilst the work is going on.

We commence with the author of the book. The author having fixed on the size of the page and the type in which his book shall be printed, the printer usually makes an estimate of the number of pages which the manuscript will occupy, and the cost of the printing. This is done with great accuracy by a process called "casting-off the copy." The words in two or three pages of the manuscript are counted, and the average number contained in one page is made the standard of the whole of the manuscript. Thus, if

Page 1	contains	97	words
2	„	99	„
3	„	101	„
4	„	102	„
5	„	98	„
6	„	103	„

The total will be 600 words.

The average number of words in each page is, then, 100. If each page of the manuscript contains 100 words, 50 pages of manuscript will contain 5,000 words. The next

step is to ascertain how many words a printed page of the size chosen will contain, and this is done by putting a few lines of the manuscript into type. Supposing, then, each page will contain 250 words, and the whole of the manuscript to be printed contains 5000 words, the book will consist of 20 pages, viz.

Words in a Page.	Words to be Printed.	
250)	5000 (	20 pages.
	500	
	... 0	

It is necessary, however, that the manuscript should be fairly and regularly written to get an accurate estimate. If there are many interlineations, or many parts struck out, or if one part is written larger or smaller than other parts, one page will not be the measure of the rest, and no average can be obtained. The words in every page must in that case be counted to get a correct estimate; but this is a process too tedious to be adopted, and, therefore, the size and cost of the book become a mere matter of chance.

The master or overseer of the printing-office, or "governor," as he is usually called, having received the copy from the author, gives

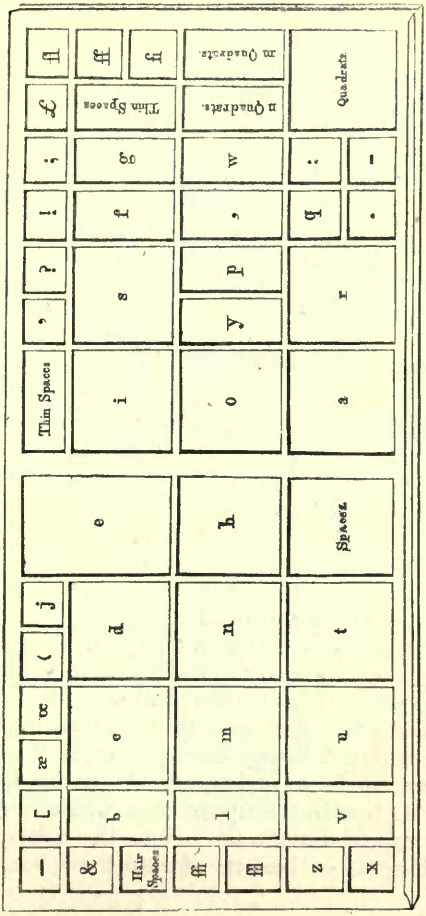
it out in portions to the workmen who are to print it. These are the "compositors," who range and dispose the types into words, lines, and pages. We shall suppose for the sake of making the description as simple and clear as we can, that only one compositor is engaged on the book to be printed, though there are generally more. The first thing the compositor does is to distribute or place in his case the sort of letter in which the book is to be printed. A philosopher has said it would take many pages to describe how to handle a wheelbarrow, though with a picture of it the operation might be described in two lines. For the same reason we give a representation of a pair of letter cases. (*See pages* 128 *and* 129.)

These cases, it will be seen, are divided into cells or boxes, in which the different letters of the alphabet are kept. The boxes differ in size, because the letters, as we have already stated, differ in number, whilst the boxes containing those used most are placed nearest to the hand of the compositor, because he may have the less distance to carry them when he is composing. This will be more clearly explained as we proceed. The cases are put on a frame and stand thus. (*See page* 130.)

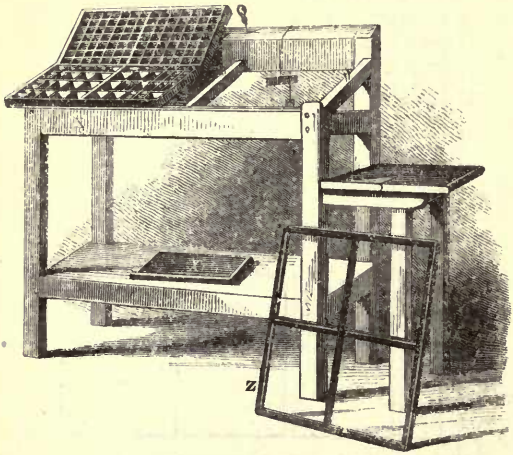
A frame usually contains two pair of cases, one with the Roman fount, and the other with the Italic; the latter is not shown in the cut. The letter is placed in the cases in this way.

A B C D E F G
H I K L M N O
P Q R S T V W
X Y Z Æ Œ U J
ä ë ï ö ü
1 2 3 4 5 6 7
8 9 0 ç ß k
A B C D E F G
H I K L M N O
P Q R S T V W
X Y Z Æ Œ U J
ä ë ï ö ü
1 2 3 4 5 6 7
8 9 0 ç ß k

Upper Case.

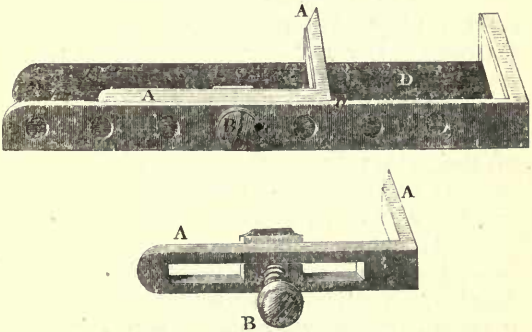

Thin Spaces
Hair Spaces
Spaces
Quadrats
n Quadrats
m Quadrats
Thin Spaces

Lower Case.



The compositor takes up a "handful" of type, that is, ten or twenty lines which have been composed in printing some other book, with a rule or lead, and holding it in his left hand, takes word after word of it between the thumb and fore-finger of the right hand, and beginning with the first letter of the word, separates each letter from the rest, and drops the whole of them one after the other into the boxes to which they belong. For instance, if the word taken up is "London," he drops the L into the L box in the upper case, which contains the capital letters, the *o* into the *o* box, the *n* into the *n* box, the *d* into the *d* box, and

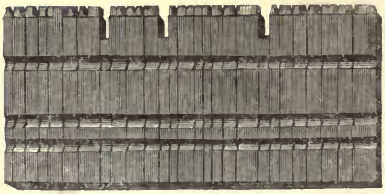
so on until the word is distributed. The small letters are placed in the lower case. The words are read upside down; but practice makes perfect, and a good workman will distribute 40,000 letters in a day. He separates them indeed almost as rapidly as he can pass his hand over the case. When the case is full, the compositor commences composing. For this purpose he stands in front of the case, in the centre of its length, at X, and holds in his hand a composing-stick.



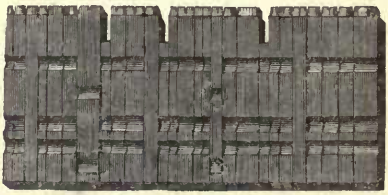
In this instrument the letters are arranged into words and lines. It is from seven to ten inches long, and is generally made of iron. The ledge A A is a slide secured by the screw B, and the holes are for the purpose of

moving the screw and the slide. The slide is used for making the space D wider or narrower, according to the width of the page which is to be printed. The width of this space is the width of the page. The stick is held in the left hand, the forefinger being bent under it, pointing towards the compositor, so that the thumb may be over the slider into the space D. In other words, the stick rests on the fingers and part of the palm of the hand. A piece of thin brass (called a setting-rule) having been placed inside against the ledge F to support the letters, the compositor with the right hand selects the letters he requires from the cases. For instance, if we were going to compose the words "London is a vast city," he would take a capital L from the upper case, and place it in the left-hand corner of the stick; then putting his left thumb upon it to hold it firm, he picks up *o* from the lower case, ranges that next to L, and proceeds in the same way, until he has ranged the whole of the letters of the word London. Next, he places a space to make the division between "London," and the next word "is," and then he proceeds letter by letter until the line is finished. If the words in the line fill it exactly, nothing remains to be done but to ascertain that the words are correctly spelt, and to make the line tight, by inserting a thick or thin space as may be necessary; if there is not room for the whole

of the last word, part of it is turned over into the next line, or if it is a word which will not admit of being divided, such as "through," the spacing (that is, the distances between the words) is lessened, so as to get it in, or it is increased so as to fill the line without it, and drive it over into the next line. But before tightening the line, the compositor reads over the type to see if he has left out any of the words, or put in any twice over, or if he has spelt them correctly; and as the letters of different founts will get mixed, he runs his left thumb along the front of the letters to feel, if they are all of the same fount. In doing this, too, he is assisted by notches called *nicks*, which are cut in the body of the type. Each fount has a particular nick, consisting of one, two, or three notches cut in a particular part of the body of the letter, so that when the letters are arranged in a line so many grooves are formed. By this simple contrivance the compositor is enabled to see at a glance, and even to feel without seeing, whether any of the letters are turned the wrong way, or whether any of them are of the wrong fount, because the lines of the grooves are interrupted. Supposing, then, the letter is a three-nick letter, the appearance of the lines will be as follows:—



If, however, any of the letters are turned the wrong way, or any wrong founts are mixed, the appearance will be similar to this:—



The first line of the copy having been completed, the compositor removes the piece of brass, of which we have already spoken, from the back of the type to the front of it. Its use now is not merely to support the letters, but its smooth and even surface facilitates the ranging of them. The process of composing may seem a tedious one, but it really is not so; for while the fingers are travelling to the letter wanted next, take it out of the box,

and convey it to the stick, the eye glances at the copy, which is placed on the upper case in a line with it, where it is most readily seen; and thus the compositor proceeds, alternately selecting with his eye a letter which lies in a convenient position to be picked up, picking it up with his fingers, while glancing at his copy, and accumulating line after line with considerable expedition. A good compositor will "set" 12,000 of pica letters in a day.

Several machines have been constructed for composing types. One of these was shown at the Great Exhibition in 1851, and is now at work in a newspaper office in Denmark. Another has been invented by a gentleman named Wiberg, of Lund, in Sweden, who, at the time we write, is about to visit England, with the view of getting it into use. A third invention, which comprehends a complete change in the whole system of printing, was exhibited during the year 1853, in London, by Major Beniowski. We will endeavour to explain the principles of the new process, which is a combination of logography and mechanism. Some of the types consist of single letters, like the ordinary types; others have a space attached to them. A space, as we have already described, is a piece of metal having no letter on it, and therefore shorter than the other types, used to create the blanks which separate the words of a sentence. In a line of ten words there are about fifty letters and ten spaces, and to pick up each space re-

quires the same amount of time and exertion as it does to pick up a letter. If, however, the compositor can pick up the space attached to the letter, which is to form the final letter of the word—that is, if he can pick up a letter and a space by one motion of the hand instead of two, he would save one-fifth of his labour. The diphthongs, double vowels, double consonants, and syllables in general use, are cast in one piece; so are the articles, prepositions, conjunctions, and auxiliary verbs, such as "am," "can," "should;" so are the prefixes of words, such as "com," "con," "dis;" and the terminations, such as "tion," "ment." We will instance the application of the system by the following sentence:—

"London is the largest city in the world."

To set up this line in single letters the hand must make forty-five lifts, including the spaces. According to the system we are describing the words would be composed in sixteen lifts, as several of the letters are united:—

Lo-nd-on -is -the -la-r-ge-st -ci-ty -in -the -wo-r-ld.

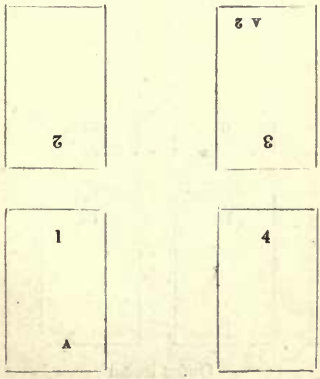
The dashes between the letters show the pieces in which the letters are cast. By this mode it is calculated that there would be a gain of 150 per cent. in labour as compared with the single-letter system. The logographic plan failed, it will be remembered, owing to the vast size of the cases required to contain the

types. But Major Beniowski's cases are not larger than the ordinary cases. They are not, however, divided into boxes, each containing a particular sort of letter, but consist of a number of columns or shutes, standing nearly upright, side by side. The composing is facilitated by a mechanical contrivance. The letters are placed, each sort in a separate column at the top, and they slide down in single rows, until the bottom letter touches the front of the case; thus, as soon as one piece of type is taken away from the aperture at the bottom, another falls into its place from behind, and is ready to be used in turn. The type is taken out of the aperture with pincers, by which means space is economized. Under the aperture the letter or letters which it contains is marked, and the feet of the type also bear upon them, legibly stamped in black on a white ground, a letter or letters similar to that on the top, which is to be used in printing. An eye-witness states, that he saw a young lady compose several lines of copy, containing 255 letters, including spaces, in three minutes, being at the rate of 4,700 letters an hour, or nearly as many as could be composed in half-a-day in the usual manner. The advantages of this machine, we are told, are, that any person of moderate intelligence may compose types by its aid after a few weeks' practice; that the long training of the compositor may be dispensed with; that women

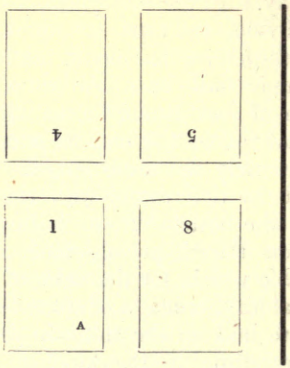
and children may be substituted for men in printing offices, as the fatigue and unhealthiness of the trade are considerably diminished by the machine; that children who know no more than the alphabet can place or distribute the type in the columns; and that the liability to typographical errors is considerably diminished. Whether the machine will or will not effect this has yet to be proved; but up to the present time we have not heard a single instance in which it has superseded the use of the simpler composing-stick in England. We now resume the thread of our narrative.

A composing-stick generally holds about 10 lines of pica. As soon as the compositor has filled it, he empties the matter into a *galley* with his fingers, lifting out all the letters in a mass. A galley is a thin piece of board with a ledge on one side and one end of it, not unlike a boy's slate, when two sides of the frame are taken off. In the engraving on p. 130, a galley marked X will be seen lying on the bed of the frame. When enough matter has been composed to make a sheet, the compositor proceeds to impose a form. Imposing is the arrangement of the pages in such a manner that when the sheet of paper on which they are printed is folded, they shall follow and read on in regular order. This is a very clever operation, and it may be useful to describe it at length, especially as persons who are ignorant of the principle of paging, often

cut and fold pamphlets and newspapers the wrong way. In the first place, then, the compositor divides the type set up into pages of the length determined upon, taking care that each page shall have the same number of lines; or, if that cannot be managed, that the pages that fall on the back of each other shall be of precisely the same length. The pages having been tied round with small twine, to prevent the letters from falling, they are placed on the imposing-stone. This is a large table which, for the sake of smoothness and durability, is made of stone or iron. The pages are laid on the stone in different positions, according to the kind of book which they are to form. For instance, a sheet of folio contains four pages, that is, two on each side; the pages would be laid thus:—

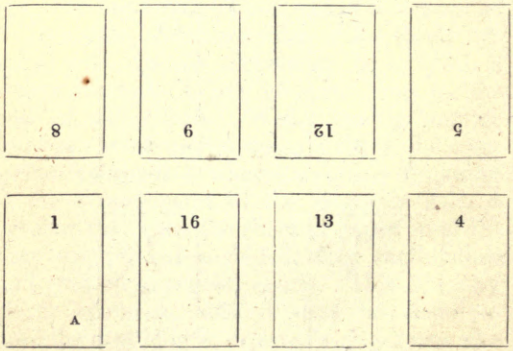


A sheet of quarto, containing eight pages,



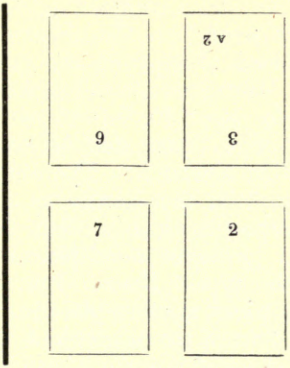
Outer Form.

A sheet of octavo, containing sixteen pages,



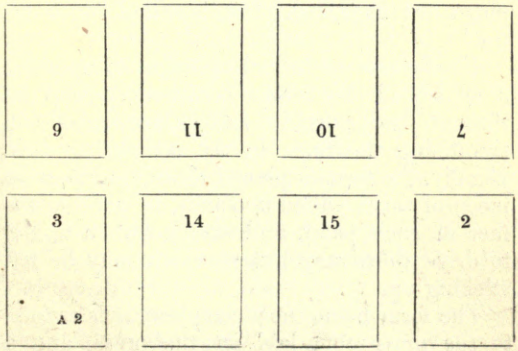
Outer Form.

four on each side, thus :—



Inner Form.

eight on each side, thus :—



Inner Form.

The pages, when they are ranged in their proper places, are fastened together in a chase. This is an iron frame having one or more cross bars to separate the pages from each other. If the reader will turn to the cut of a frame in page 130, he will see near the letter Z a quarto chase, that is, one for four pages, standing against it. The width of the bars serve to form the margin as well as to separate the pages, which is, when necessary, increased by pieces of wood placed between them and the type. Pieces of wood called side and foot sticks, are then placed against the sides and bottoms of the pages which do not rest against the bars of the chase, and quoins, or wedges of wood, being inserted between them and the side of the chase, are driven tight with a mallet and a shooting-stick, and the pages are made fast. This is called "locking-up."

The form when locked-up ought to resemble a solid block, but letters occasionally drop out through bad work in *justifying*, that is, in tightening the lines in the composing-stick. Finally, the form is planed down, that is, a flat piece of wood, called a planer, is laid on the face of each page, and struck with a mallet to drive down any letters which may be left sticking up.

The form being now complete, it is carried to the press-room, laid on the press, and a first proof is pulled, that is, a sheet is printed.

The form is then carried back to the composing-room, and laid on the imposing-stone to be corrected. The proof itself is taken to the reader, and a boy reads the author's copy aloud, and the reader sees that the printed proof agrees with it, or marks the errors for the compositor to correct. We shall now perceive why it is better that the author's manuscript should be well written. If it is so, the proof will be *clean*, that is, there will only be a few mistakes in spelling. But if it is badly written, then it will present not only bad spelling, but wrong words, and sense will be often converted into nonsense. This is almost invariably more the fault of the author than of the compositor; for the latter never makes a mistake if he can help it, as he is not paid for the time or labour he may consume in correcting the proof. He is bound, in truth, to make the print an exact copy of the manuscript. Nothing is more common, however, than to send badly-written copy to be printed—much to the loss of the compositor, who wastes his time in making it out, and correcting his mistakes; and much to the annoyance of the author himself, as when there are many mistakes in a proof, some of them are almost sure to pass unnoticed. Mr. Savage states in the *Dictionary of Printing*, that he has met with authors who believe that the worse the copy is written the more correctly will the book be printed, because the

compositor will take more trouble in understanding it. It is thought, indeed, that compositors can make out anything. This is true to a considerable extent, if they happen to have a previous knowledge of the subject to which the book relates, but if they are ignorant of it, then they cannot help making blunders. Yet it is a common thing for authors, who cannot make out their own writing, though they know the subject treated of, to complain that the compositor cannot read it correctly, though he knows nothing of the subject. It is said of Dr. Rees, the editor of the well-known *Cyclopædia*, that his writing was so bad that it seemed as if he used a burnt stick, and that on one occasion the printers clubbed their money and presented him with a hundred good pens, begging him to use them for their sakes if he did not for his own. But, perhaps, the worst copy ever put into the hands of printers was the poetry of the Rev. William Lisle Bowles—at least nothing could have been worse. Mr. Bowles wrote on the inspiration of the moment, in place or out of place. Moore, his brother poet and neighbour, tells us in his Diary, that he once left Bowles at the White Hart, Bath, dictating poetry to the waiter! But he composed slowly and laboriously, and altered and re-wrote again and again, until nothing remained of the original lines, sometimes not even the general concep-

tion. His manuscript was always covered with interlineations, crossing and even interlacing each other; it was blotted and irregular; and, moreover, his writing was amongst the worst, if it were not *the* worst, that the hand of man ever wrote. There is a joke told of a lawyer who wrote three hands—one that he could make out himself, one that his clerk could make out, and one that neither of them could make out. This was really Mr. Bowles's case. Sometimes he could make out his own handwriting; sometimes the printers could make it out for him; but sometimes neither of them could make it out. "At the time when we printed for Mr. Bowles," says the editor of the *Bath Chronicle*, "we had one compositor in our office (he died in the same week with Mr. Bowles), who had a sort of knack in making out the poet's hieroglyphics, and he was once actually sent for by Mr. Bowles into Wiltshire to copy some manuscript written a year or two before, which the poet had himself vainly endeavoured to decipher."

The reader, when he has examined the proof, sends it back to the compositor, that he may correct his faults. The form being unlocked or loosened on the stone, he takes a bodkin—a sharp piece of steel stuck in a handle, very much like a large needle—and changes the wrong letters; takes out the doubles, or the words which ought not to have

been printed; and puts in all those which have been omitted. To put in or take out words is very troublesome, as it disarranges all the lines succeeding it. To effect it the compositor *overruns* the matter; that is, he breaks it into fresh lines until the "out" is squeezed in, a little in each line, or until the double is spaced out, by increasing the spacing or distances between the words.

A second proof is now printed in the same manner as the first. This is called a *revise.* The reader compares it with the first proof, to see if the errors have been corrected, and also glances over it to detect any errors which may have escaped himself. The revise is returned to the compositor for correction in the metal, and after this has been completed, a third proof is printed. This is sent to the author for his corrections, and when they have been made a fourth proof is printed. This is read by the reader to see that the author's corrections are made, and to detect any errors which may have escaped the author and himself. When the errors, if any, have been corrected in the metal by the compositor, the form is ready for press. The first sheet printed is, however, treated as a proof, being examined by the reader to see that the numbers of the pages, the margin, and other things, are all right.

It may naturally be supposed that with so much care all errors would be expunged. Yet, perhaps, there is scarcely a book printed

which is entirely free from errors of the press. A celebrated French printer, famous for his accuracy, some years since challenged the world to find a single error in one of his books, when some one sharper-eyed than himself, detected forty, and broke the printer's heart. Some escape the reader; sometimes a mistake is made in the author's corrections, a wrong word being used, or the right word is put in the wrong place; sometimes the compositor in correcting one error makes another, just as the tinkers are reputed to make many holes in mending one; and, again, letters at the edges of the pages are apt to get broken off in the press or are drawn out by the inking-rollers, or the ends of the lines slip. Some of the early editions of the English Bible were very incorrectly printed. In an edition printed by Barker and Lucas in the year 1632, the word *not* was omitted from one of the Ten Commandments, and thus the Bible was actually made to teach the very sin which it forbids. The printers were heavily fined for this error, and the edition was suppressed. In a beautiful edition printed at Cambridge University in 1653, it was set forth, "know ye not the *un*righteous shall inherit the kingdom of God." The *righteous*, of course, was meant. An edition, revised with great care by Dr. Blayney, was printed at Oxford University in 1769. This was considered a model of accuracy, yet, at the end of thirty years, it was

found to contain no less than 116 errors, and one of these was an omission of great importance. The discovery was made in this way. In 1806, Mr. George Woodfall, the celebrated London printer, printed a new quarto edition of the Bible. The copy printed from was the Cambridge edition, then in common use. The proofs were read and corrected in the first instance by the Oxford edition, and a multitude of gross errors were detected in the Cambridge copy. The proofs were next read and corrected by Dr. Blayney's edition, and no less than 1,200 errors were detected in the Oxford copy. Furthermore, 116 errors, as already stated, were detected in Dr. Blayney's copy. After the last proofs of Woodfall's Bible were taken, the forms were never removed from the press until the printing of the different sheets of the edition had been completed, to prevent errors creeping in by the displacement of letters. Up to the present moment only one error has been discovered in this edition of the Bible. This is surprising accuracy, remembering that every page of an octavo Bible contains more than 2,000 distinct pieces of metal, and every sheet between 30,000 and 40,000, the misplacement of one of which would create a blunder. Yet there are cases in which errors have added to the value of books, instead of diminishing it. For instance, the Sixtine Vulgate, or the Bible of Pope Sixtus the

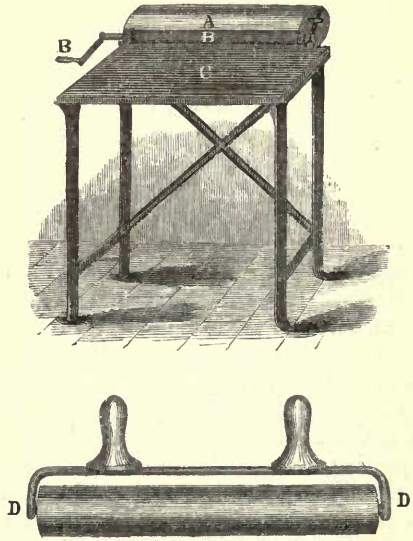
Fifth, was printed in the Vatican at Rome in 1590. The Council of Trent had declared "that the Vulgate alone should be esteemed authentic . . . and that no one should dare to reject it on any pretence whatever." The Pope certified that this edition was an exact copy of the text. Yet no sooner was the book published than it was found to be full of misprints and other errors. At first, the correct words and alterations were printed on separate slips of paper, and stuck over the incorrect passages. But this greatly disfigured the book. Gregory the Fourteenth eventually ordered the edition to be suppressed, and a new edition was printed. The Bible of Pope Sixtus was thus converted into a rarity, and it is now much more sought after for its errors than the edition which superseded it is for its greater accuracy.

We have so fully described the printing press already, that a very brief description is required of the remaining operations in printing the sheet. The form having been laid on the table of the press, is "made ready." The tympan is wetted, and a sheet having been laid on the face of the type, the tympan is turned down, the table rolled in under the platen, and the platen pressed down on the tympan and form, by pulling the bar handle. When the table has been rolled out again, and the tympan opened, the sheet of paper is found sticking to the tympan, having been

brought off the type by sticking to the wetted surface. The paper is, of course, indented by the pages, being, in fact, an impression taken without ink. The frisket, which is covered with paper, is now cut so that the pages of the form may pass through it in printing; that is to say, apertures corresponding with the size and number of pages are cut in the paper. The effect is, that while the inked type touches the part of the paper to be printed, the cross bars and furniture of the form which also become inked, do not touch the part of the paper which is to form the margin. The printing now actually begins; the paper, which has been previously wetted to let the ink sink into it, is placed in a line with the tympan, elevated on a slanting table, called a horse. The pressman with both hands takes a sheet of paper from the "heap," and lays it on the tympan, where it is kept in its place by the frisket being brought over it, and two sharp points fixed on the tympan, so as to pierce the very centre of the sheet. While this is doing, a second pressman, stationed at the inking table, which stands in a line with the platen, inks the form with a roller made of treacle and glue, and covered with ink obtained from the smeared surface of the table. Printing ink, we may here say, is a mixture of linseed oil and lampblack.

The form having been inked, the first pressman turns the frisket down on the tympan,

thereby preventing the sheet from falling, turns both frisket and tympan, doubled up together

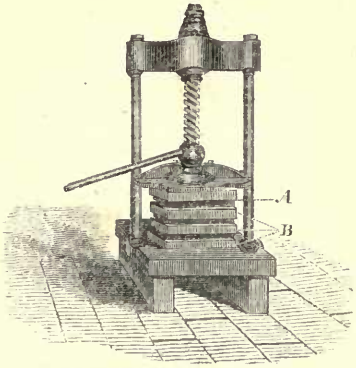


A, reservoir of ink. B, handle and cylinder, by turning which the ink is spread out. C, surface on which the inking roller, having been supplied with ink by cylinder B, distributes it. D, inking roller.

down upon the type, thereby putting the paper and type in contact, rolls the table in under the platen, and pulls over the bar handle, thereby squeezing the platen, tympan, paper, and type altogether, and effecting the printing. He then lets the bar spring back, rolls out the

table, unfolds the tympan and frisket, takes the printed sheet off the tympan, and lays it on the table beyond the unprinted paper. While he is removing one sheet, and laying on another, the second pressman inks the form again by running the roller over it. Thus they proceed continuously, until the whole of the number of sheets to be printed is worked off, at the rate of 250 sheets an hour, or four a minute. One side of the paper having been printed, the second form is worked, that is, the sheet is printed on the other side. The pages are kept back to back, or *in register*, by placing the points which hold the sheet on the tympan, through the same holes in the centre, used in printing the first side. When both sides are printed, the printed sheets are sent to the warehouse and hung up to dry, and as soon as the ink has hardened sufficiently, they are put between sheets of thin glazed pasteboard. The printed sheets thus separated from each other are placed in a book press. This is sometimes similar to a linen press, though hydraulic presses are generally used in large printing-offices. The object of this operation is to press out the indentations formed by the type in the paper. By pressing the sheets sharply in this way, they become perfectly smooth. When all the sheets forming the book are printed, they are gathered up and folded, and the binder makes them into books as they are sold in the shops.

The extensive operations of a large printing-office, and the rapidity with which they are per-



A, glazed boards.
B, wooden boards to aid the screw.

formed, may be shown by describing the production of the Official Catalogues, and other publications of the Great Exhibition of 1851. They consisted of four distinct works, a large Illustrated Catalogue in four volumes, and three small catalogues, one in the English language, the others in French and German. There were also some guide-books, lists, &c., of less importance. Messrs. Spicer Brothers, stationers, and Messrs. Clowes and Sons, printers, of London, contracted to produce these publications, at their own cost, looking to the large sale of them for their remuneration.

The first thing done was to cast two sizes of

type. It was found that 58,520 lbs. were required, containing no less than 37,152,176 separate types or letters. The printing was to be commenced within six weeks, and, therefore, no time was to be lost in casting the type. Messrs. Clowes, who are type-founders as well as printers, finding that they could not cast such an enormous quantity of type quickly enough, obtained the assistance of several other type-founders in London and Edinburgh. The work went on without cessation, until it was completed; no sooner was one set of men tired, than another took their places, by night as well as day. Type-founding, like pin-making, is effected by a subdivision of labour amongst men and boys; one casts the letters in the matrix; another breaks off the superfluous metal which becomes attached to them in casting; another rubs the sides smooth; another places them in long rows, that they may be dressed, nicked, and bearded; and another arranges them in the order they are sold. In these operations 277 men and boys were employed; each relay of 20 men and 12 boys, making about 120,000 letters a-week. Whilst the type-founders were going on, the paper-makers were equally busy. No less than 627,698 lbs. of paper were required, and from the sorting of the rags to the production of the complete sheet of paper, 338 men and women were employed in making it. The iron-founders had also to make 800 chases, in

which the type is arranged in pages for printing; and the printers'-joiners had to provide 12,000 feet of furniture, and 12,800 quoins, for securing the pages in the chases. Finally, the ink-maker had to make 4000 lbs. of ink for the small Catalogues, 400 lbs. for the Illustrated Catalogue, and 1600 lbs. for the other publications—6000 lbs. in all.

In the preceding pages we have described the printing of a book as proceeding, sheet by sheet, according to the plan generally pursued. But this was not the case of the Exhibition Catalogues; all the sheets, at least of the small English catalogue, twenty in number, were printed together, and almost at the same time. The copy of their intended contents could not be placed in the hands of the compositors according to the usual routine of authorship and printing, and thus occasioned extraordinary difficulties, which have rendered the successful termination of the work astonishing and highly honorable to the skill and industry of every one engaged in it.

The exhibitors, of whom there were 14,899, were each supplied with a blank form, in order that they might furnish descriptions of the articles which they intended to exhibit. The 14,899 descriptions thus obtained were placed in the hands of a body of literary men, who made any corrections that were necessary in the wording, and divided the articles into thirty classes, each article being, of course,

arranged in the class to which it belonged. Thus paper, ink, and type, would be placed in the class of "stationery," and soap, toys, and fishing nets, in the class "miscellaneous." On the 30th of January, the first portion of the copy was placed in the hands of the compositors, and speedily set up in type, for the Illustrated Catalogue. Proofs were then sent to the compilers, who expunged errors, rearranged the classification of some of the articles, and made other necessary alterations. The compositors having made the alterations in the forms, copies were sent to the compilers engaged to prepare the three small catalogues in the English, French, and German languages. The first compiler reduced the length of the descriptions, and expunged some portions, in order that the book might not exceed a certain number of pages, and the others translated the matter into their respective languages. The copy of these three catalogues was then put into the hands of the compositors, nor would there have been any difficulty in the printing, if the work could have been proceeded with in the usual way. But new returns were continually coming in. Sometimes matter had to be added, sometimes expunged; and articles belonging to one class were continually found in another. The repeated alterations and transformations, added considerably to the quantity of work to be done; and, indeed, they were more laborious and ex-

pensive than the original work. Great as the confusion was in the English catalogue, it was greater in the French and German catalogues. These being translations of the English catalogue, their contents were, of course, changed as the original was changed; while, to make it more difficult, French and German compositors could not be obtained. It is a remarkable circumstance that the foreign catalogues were composed by men who did not know a single word of the French and German languages. In accomplishing it, however, 62 pages of the German, and 146 of the French catalogue, were cancelled, and composed a second time; in fact the work was done over again, this being the quickest mode of classification and correction. An idea of the number of changes may be obtained, when it is stated, that the cost of the alterations in the English catalogue was four times as much as the usual cost for setting up the types. No less than 54 reams, or 27,864 sheets of paper, were consumed in proofs alone.

Ten weeks were passed in this doing and undoing. The four catalogues, amounting to 2000 pages in all, were in type, but the contents were undigested, and unarranged. Indeed, it was not until the 26th of April that any definite plan of classification could be determined upon, and four days afterwards the Exhibition was to be opened. The printers were bound under a heavy penalty to have

a large number of copies of the catalogues ready on the 1st of May, but to effect this seemed impracticable. The small English catalogue was not to exceed 320 pages; 368 pages were, however, in type; and therefore the description of the articles had to be still further reduced. Similar reductions had to be made in the French and German catalogues. The descriptions of the articles, nearly 15,000 in number, had to be collected together, in all the four catalogues, arranged in the thirty classes, in the order that they were numbered; and, in short, 100 distinct arrangements had to be effected, before the forms would be ready for press. The classification was properly the work of the literary men, but it was impossible that they could complete it in time. It was therefore left to the compositors. The type was arranged in 368 slips, each slip representing a page; the compositors collected the articles of each class in the page, and placed the type together. The type, when the classes were thus completed, was arranged in pages in the manner that the book was to be printed, and a last proof was pulled, in order that the compiler might add the numbers, by which the articles were to be distinguished within the Crystal Palace. It was not until midnight before the morning of the opening of the Exhibition, that the forms of the small English catalogue were ready for press. As for the French and German catalogues, and all but

the first part of the Illustrated Catalogue, the work had been stopped in order to insure the production of the English catalogue. In the middle of the night, then, twelve or fifteen cylinder machines were set in motion; a steam engine drove them at the rate of 700 revolutions an hour; the sheets, as they were thrown off, were distributed amongst 500 persons to be folded, stitched, and bound; and, when the Exhibition opened in the morning, copies of the small catalogue, as well as the first part of the Illustrated Catalogue, were ready for sale at the doors. The Queen and Prince Albert, on taking their seats at the ceremonial, were also presented with copies of the works, which had been printed and elegantly bound, with gilt edges, in six hours!

Thirty-seven tons of type were used, and nearly worn out, in printing the catalogue, costing 6,034*l.*; 338 tons of paper were consumed, the work of 338 persons; 152 men and boys, including the compilers, were engaged in the printing; 290,000 complete copies of the small catalogue were printed at 15 cylinder machines in 42 days; the whole of the time during which the work, from the casting of the type to the completion of the last copy of the catalogue, was going on, was 216 days, counting nights as days; and as the labour of the printers did not really commence until within four days of the opening of

the Exhibition, so neither did they terminate until within four days of its close.

The printing of the Exhibition Catalogue is an instance of a large quantity of work done with remarkable rapidity. We are enabled to append a far more remarkable instance of speed merely. There is at Paris a printing-office, called the *Imprimerie Catholique*, which furnishes a striking example of what may be effected by an energetic man. The Abbé Migne, the proprietor of it, commenced his operations about thirteen years ago, with little means of any kind, and now has 330 workmen constantly employed. A large octavo volume, in double columns and very close type, is often printed at this office it is said in a couple of days.

We may conclude this part of the subject with an anecdote which displays a very common notion of the manner in which books are printed. An old woman from the country, once entered a printing-office at New York with an old Bible in her hand. "I want you," she said to the printer, "to print this Bible over again; it's getting a little blurred, and my eyes are not what they were. How much do you ask?" The printer, who liked a joke, replied, "Half-a-dollar." "Can you have it done in half-an-hour?" asked the old woman, adding, "I wish you would, for I want to be getting home, as I live a great ways out of town." "Certainly." The printer, when the

old woman left the printing-office, sent to the depository of the American Bible Society, and bought a copy for half-a-dollar. "Gracious me!" exclaimed the old woman, when she came to look at it, "how capital you have made the old book look! it's almost as good as new. I never saw anything so curious as this printing is!"

Ancient Customs.

Many curious customs have prevailed in printing-offices, and some few of them are still observed in small offices in the country. A set of laws grew up out of custom, and these were administered by a regularly-recognised body called the *Chapel*. Every workman in the office was a member of the chapel, excepting the overseer, and was entitled to vote in its deliberations. The president, who was generally, though not always, the oldest printer in the house, was styled the Father of the Chapel. The proper business of the Chapel was to preserve the property of the master, to settle differences between the master and the workmen, and to maintain good behaviour amongst the men. Not only did the Chapel enforce the existing laws of the trade, but it was competent to make new regulations to meet emergencies.

First, let us show how the Chapel acted for the master. By the existing laws a fine was imposed upon any workman who threw about

the type and other printing materials; or who by neglecting his duty hindered other workmen, or who left the premises without extinguishing his light. We will describe the course of proceedings in the last offence. The workman who discovered another workman's light burning, after he had left the premises, extinguished it, and if it were a candle, put on a paper extinguisher, and delivered the candlestick to the Father of the Chapel, who kept it until the offender paid or promised to pay the fine. If it were a gas-light, the fact that it had been left burning was reported to the Father. But it might happen that a workman was called out of the room in which he was working, into the open air, which was considered leaving the premises. If he intended to come back to resume his work, he had only to say to any other workman in the same room, "Mr. ——, take charge of my light," and that person became responsible for it. If Mr. ——, after being thus put in charge of another man's light, left the premises without extinguishing it, the fine was inflicted on him. There was so much danger in leaving lights burning that this fine was never remitted. Even the master was liable to it. The workman paid 6*d.*, the overseer 1*s.*, and the master half-a-crown for the offence. These fines took effect, as a matter of course, without calling a meeting of the Chapel for the consideration of the offence.

But the principal employment of the Chapel

was in the government of the affairs of the men ; and in order that its deliberations might be free and unfettered, neither the overseer nor the master could be a member, and neither of them was permitted to be present at its meetings. If a workman wished to obtain the judgment of the Chapel on any subject, he gave notice to the Father, stated generally what he wished, and paid a fee of one penny. The Father might consider the matter trifling, and decline calling the Chapel, and he alone possessed authority to call it. But if the applicant increased the fee to the value of a gallon of porter, the Father must call the Chapel, or he himself might be turned out of his post. The Chapel was held round the *imposing-stone*, and a certain quantity of porter was drunk during the deliberations, the cost being levied on the summoning or summoned party, according to circumstances. The person at whose request the Chapel was called, stated the case in which he required the advice and decision of his fellows. Perhaps it was a difference between the workman and the master about wages. In such a case the Chapel fixed the price which should be paid ; and if the master refused to pay it, the workman must quit his situation rather than permit the decision of the Chapel to be overruled. He was required, in truth, to sacrifice himself for the benefit of the rest of the workmen ; as his case would form a rule applicable to all other similar cases. Perhaps the Chapel

was summoned to decide a difference between two or more workmen. In this case the Father gave the party complained of notice to attend the Chapel. If he did not present himself, the Chapel fined him for his contempt of court; and then in his absence entered upon the matter in dispute. When the members of the Chapel could not agree in their decision they settled the matter by *chalking*. For this purpose the words *For* and *Against*, or *Yes* and *No*, were chalked at the top of a large galley, which was then placed on a frame in some part of the room where it could not be overlooked. The members of the Chapel went to the place, one at a time, and signified their opinion by making a chalk mark under the word which expressed it. The first person who voted usually made a mark under the word which would lead to a lenient decision, thereby saving himself from personal ill-will, as it must be known to the second voter how he had voted. The second voter usually marked on the severe side, so that the persons coming after the first and second voters could not tell how either of them had voted. When all the members of the Chapel had voted, the Father summed up the votes, and declared what, according to the majority, was the judgment of the Chapel.

Against the judgment there was no appeal. It was a maxim that the Chapel could do no wrong. To find fault with its judgment was itself an offence punishable by a fine. What-

ever the decision of the Chapel was, it must be obeyed without a murmur, and if it were disobeyed, most unpleasant consequences followed.

For instance, supposing a workman was willing to receive a lower price for his work than the Chapel had fixed. Perhaps he had submitted, preferring to take less pay than lose his situation. But his fellow-workmen regarded such conduct as personal selfishness, gratified at the expense of the general good. He was nicknamed a "Rat," and various expedients were used, either to bring him into subjection to the Chapel, or to drive him out of the office. His composing-stick was taken away; or his galleys; or the twine with which the pages he had composed were tied up was cut, his matter broken into *pie*, that is, thrown into confusion like a house when it falls down; or the letters in his cases were mixed; so that he could not proceed with his work. This was all called the work of *Ralph*, an imaginary spirit which was said to walk whenever the mandates of the Chapel were disobeyed. Such treatment was generally sufficient for the purpose, for whatever work the workman did was undone for him; and he had far better do nothing at all. If, indeed, he did not quit the office of his own free will, the master discharged him, because he was really a hindrance to business. But if he remained in defiance of *Ralph*, then the members of the Chapel proceeded to *smoke* him. They sur-

rounded his frame, each holding a lighted match, and sung a doleful ditty. From this time forth he was "sent to Coventry," and shunned like the plague. Nobody must speak to him, or instruct him, or assist him, or work in companionship with him. Any person who did so was fined. The contumacious workman must, then, either quit the office, or submit. If he took the first course, his character was sent to his new place of employment by *Miles's boy*, and he was driven from thence; if the last, all the mischief which *Ralph* had done secretly, was repaired by the members of the Chapel openly.

We are told by Moxon that the Chapel has existed "time out of mind." The origin of the name is unknown. Printers generally believe that the *Chapel* is so called, because Caxton first printed in a Chapel. Moxon suggests that it was a title conferred by the courtesy of some great Churchman, or adopted because the first printers were chiefly employed in printing religious books.

Anciently there were nine cardinal offences of which the Chapel took notice. Amongst these were swearing, fighting, abusive language, or giving the lie, and drunkenness. The punishment for each of these nine offences was called a *solace*—a consequence anything but solacing. It was another kind of "horsing." The solace was inflicted in this way. Some of the workmen took the delinquent by force, laid

him on the imposing stone, whilst another workman gave him with a board, 10*l.* and a purse, that is, eleven blows laid on without mercy. The solace might always be bought off, however, the money going to the good of the Chapel. Besides the solaces for the nine cardinal offences, there were in some offices particular solaces; such as for talking about spending the Chapel money before Saturday night; for clubbing pence together to send out for drink; and for gaming with quadrats, throwing them like dice for money or drink. Masters sometimes purchased a solace from the Chapel against workmen injuring their property, and they were sure it would be enforced as the fine went to the Chapel. A workman might also buy a solace; for instance, if a workman sung in the Chapel, and another were offended by it, the offended workman might lay down a penny, and buy a solace of twopence, to be inflicted on the offender if he sung again. There were also solaces against strangers; thus, it was a solace for any one to come into the king's printing office, and ask for a ballad; to inquire of a compositor if he had news of such a galley at sea (a joke founded on the galleys which are used by compositors in their work); or to bring a wisp of hay to a pressman. These were tricks played off upon the unwary by persons who knew the customs of the office, just as boys now send each other to a shoemaker's shop for a bottle

of strap oil. There were also some other customs. Every new workman was required to pay half-a-crown on commencing work as a *benvenue*, a term derived from the French words *bien venue*, or welcome, a custom still continued under the name of *footing*. If a man married, he paid half-a-crown; if his wife came to the Chapel, she paid sixpence, and all the members clubbed twopence each to welcome her; if he had a son born to him he paid a shilling, and if a daughter sixpence. The solaces, fines, and fees were spent in providing bread and cheese and beer for the entertainment of the members of the Chapel. The Father drank first. But sometimes the Chapel would present a workman with a *token*, consisting generally of a marked coin, and on producing this he was not only entitled to drink first, but last.

To give the lie was, as we have said, an offence against the Chapel. The workmen, therefore, contrived another way of contradicting persons who told improbable stories. It was called "the wash." When a workman said anything which his fellow-workmen disbelieved, each of them with a piece of wood or other substance, struck along the front of the case, just as boys do along house-palings, thereby making a loud rattling noise. This was called "washing" the offender, and the louder the noise was the better was the "wash." The story was thus effectually stopped, whilst

no particular offender could be discovered. When a workman received notice of his discharge he was said to have received the *qui*, a contraction, it is supposed, of *quietus est*, a grant of which discharges a sheriff from all accounts due to the king. If a workman were dismissed without previous notice, which was only done for bad conduct, it was said that he had "got the bullet." The origin of the saying is unknown. It may relate to the propensity of bullets to go off suddenly, or it may be a variation of the expression "getting shot of him."

The pressmen jocosely called the compositors "donkeys." The compositors retorted on the pressmen by calling them "pigs," and the press-room the "piggery." If a compositor wished to annoy a pressman he uttered a grunt. But this could only be done with impunity in the composing-room, for the pressman had no remedy, having no business there. But if the annoyance were offered in the pressroom, the pressman might resent it, the compositor having no business there. The compositors were also called "galley slaves," in allusion to the galleys which they are constantly filling and emptying, and the pressmen "horses," because their work is very hard.

Every year the whole of the printers employed in an establishment hold a Way-goose, or Wayz-goose, that is, a stubble goose. This is the name given to a feast provided at the master's expense. Formerly the workmen

did not work by candlelight until they had held the Way-goose. It was the first sign of winter with them. Now, however, the feast is usually held in July, and there are very few offices in which the custom has ceased to be maintained. One of the standing toasts on these occasions is "The music of the press." This is the creaking of the presses, the thumping of the rollers, the rumbling and crashing of the machines, and all the other noises which salute the ear when an office is in full work. The master and workmen alike find the finest music in the greatest discord, because it brings one wealth and the other employment, and hence both pronounce the "music of the press" the finest in the world.

Many of the ancient customs of printers have disappeared. The use of steam, the substitution of machines for presses, and the growth of intelligence amongst the workmen themselves, is fast sweeping them away not only from practice, but recollection. The Chapel still, however, flourishes; and notwithstanding the members deliberate in their cups, many employers consider there is usefulness, and undoubtedly there is justice, in these rude courts of appeal.

Printing of the English Bible.

The printing of the Holy Scriptures in the English language forms an interesting episode

of the history of Printing. The Bible was translated into English by Wickliffe, as early as the year 1360, but it was not printed in England until two centuries afterwards, that is, one century after the discovery of printing, because the diffusion of the Word of God amongst the common people was treated as an offence against the religion and the government of the country. Wickliffe was accused of casting the Gospel like a pearl before swine, and Parliament would have suppressed the written copies of this English version, if it had not been restrained by John of Gaunt, uncle to Richard II., who declared: "We will not be the dregs of all, seeing other nations have the Word of God, which is the law of our faith, written in their own language."

William Tyndale made another translation in the reign of Henry VIII. He desired that every boy who drove the plough might be acquainted with the Word of God. The Reformation had at this time been commenced in Germany, and one of the points advocated by the Reformers was the open Bible. King Henry wrote a treatise in defence of the seven sacraments of the Roman Catholic Church which had been attacked by Luther, and Pope Leo X. was so pleased by it, that he conferred on the king the title still borne by the English monarchs of "Defender of the Faith." Luther replied so bitterly that Henry was incensed

against him, and, in consequence, prejudiced against the translation of the Scriptures into the vulgar tongue, which Luther recommended to his followers in every country. Tyndale, therefore, went to Cologne, and commenced printing his translation in that city. The curiosity of one Cochlæus, a deacon of the Roman Catholic Church, was drawn to the work: he could not understand why two Englishmen, Tyndale, and Roye, his assistant, should be lurking in Cologne. He discovered that they were engaged in printing a book; he scraped acquaintance with the workmen, and having plied them with wine, wormed out the secret. They boasted that Henry VIII., and his minister, Cardinal Wolsey, would soon become Lutherans. "How so?" he asked. The workmen then said they were printing three thousand copies of the New Testament in the English tongue, and that they would be secretly distributed in England before the king could prohibit it. Cochlæus denounced Tyndale to the authorities, and out of deference to Henry, the printing was stopped, and Tyndale was barely able to escape from Cologne with the sheets already printed. He proceeded to Worms, set the printers to work again, and there in 1526 produced a New Testament in octavo. This was the first English Testament ever printed. The edition commenced at Cologne was in quarto, and was completed at Worms.

The copies were stealthily conveyed to England as opportunities offered. No less than five hundred were smuggled over, concealed in a cargo of corn, and were distributed amongst the friends of the Reformation. The Roman Catholic authorities of England were greatly offended at the circulation of the book. Cuthbert, Bishop of London, published a pastoral, setting forth that "many maintainers of Luther's sect ..... have craftily translated the New Testament into our English tongue, intermingling therewith many heretical articles and erroneous opinions, pernicious and offensive, seducing the simple people, attempting by their wicked and perverse interpretation to profanate the Scripture." The bishop, therefore, commanded those clergymen and others who possessed copies of Tyndale's translation to deliver them up, that they might be burnt. The king also threatened that the persons who did not give up the books to be burnt should be burnt themselves. The celebrated Sir Thomas More agreed in the general opinion as regarded the diffusion of the Scriptures in the vulgar tongue. More was a good man, as well as a great one. Erasmus, the pious and learned scholar, who had visited his house, said that "it would be more just to call it a school, and an exercise of the Christian religion." More was, nevertheless, prompted by his conscience to burn all the copies of Tyndale's version of the Scriptures

which he could obtain. Bishop Tonstal even sent an agent to Antwerp, where Tyndale lived, to buy all the copies in existence from Tyndale himself. But these measures defeated their own object: as, so far from diminishing the circulation of the Scriptures, it was thereby increased. For as it was necessary to buy the copies before they could be burnt, the money for which they were sold furnished the means of printing new editions. In 1534, Tyndale, assisted by Miles Coverdale, published a translation of several books of the Old Testament. But two years afterwards he shared the fate awarded to his translations, having been burnt himself. Tyndale had made himself obnoxious to King Henry by writing against his divorce from Queen Katharine, as well as to the pope, by writing against the supremacy of Rome. He was seized, it is said, by the contrivance of the English agents; he was imprisoned in the Castle of Vilvorde, near Brussels, for two years, condemned at length as a heretic, and upon this sentence, says Fox, he was brought forth to the place of execution, was there tied to the stake, and then strangled by the hangman, after which his body was burnt to ashes. Tyndale's last words were—"Lord, open the eyes of the king of England!"

Miles Coverdale completed the work of his friend in the translation of the Old Testament. He used Tyndale's translation, as far

as it went, and translated the remainder in equally fine and exact English. This, the first English Bible, was printed at Zurich, in 1536, the year in which Tyndale was burnt. At this time a great change had taken place in the religious affairs of England. King Henry openly favoured the Reformation. Sir Thomas More had been thrown into prison for upholding the authority of the pope. The Parliament had proclaimed the king supreme head of the English Church. The clergy assembled by royal command, declared that the pope had no more authority in England than any other bishop. These events were proceeding while Miles Coverdale's Bible was being printed, and emboldened by them, he dedicated it to King Henry. "The blind bishop of Rome," he wrote, "no more knew what he did when he gave his highness this title, 'Defender of the Faith,' than the Jewish bishop, Caiaphas, when he prophesied that it was better to put Christ to death, than that the people should perish: that the pope gave him this title, because his highness suffered his bishops to burn God's word, the root of faith, and to persecute the lovers and ministers of it, where in very deed he prophesied that by the righteous administration of his highness, the faith should be so defended, that God's word, the mother of faith, should have its free course through all Christendom, but especially in his highness's realm; yea, even

the true faith of Christ, no dreams, no fables, no heresy, no papistical inventions, but the uncorrupt faith of God's most Holy Word." King Henry handed Coverdale's book to the bishops for their judgment upon it, and asked if they approved of it? "There are many faults therein," was the reply. "Well, but are there any heresies maintained thereby?" The bishops answered, "None, that we can find." "Then," said the king, "if there be no heresies in the book, in God's name let it go abroad amongst the people." Lord Cromwell, the minister of the king, ordered that the clergy should lay copies of Coverdale's Bible in the parish churches throughout the land, "for every man that will, to look and read therein, * * * whereby they may better know their duties to God, to their sovereign lord the king, and to their neighbours." The proclamation was welcomed with joy, not only amongst the learned, but amongst the simple. Those who were rich enough bought copies of the volume; those who were poor flocked to the places where it was publicly read. Many old people even learned to read, says Strype, expressly to search the Scriptures for themselves.

The next edition of the Bible was put forth by John Rogers, who had succeeded Tyndale as minister of the English factory at Antwerp. He was a clever linguist and a fine scholar, and undertook the task to vindicate the cha-

racter of the man whom he admired, from the imputation of heresy. This edition was printed at Hamburg, at the expense of two English printers named Grafton and Whitchurch, the former of whom had also been engaged in printing Tyndale's and Coverdale's editions. It is known as Matthews' Bible. Rogers published it under an assumed name, to avert any ill consequences. The unlimited publication of the English Bible was not yet authorized, though not exactly forbidden. Rogers probably feared that the favour shown to Coverdale might be withheld from himself.

The desire to possess the Scriptures increased greatly. The Dutch printers, therefore, determined to print a smaller and cheaper edition than any of those already issued. But Grafton the printer petitioned the king to restrain them. He set forth that he and his friends had spent 500*l.*, an enormous sum in those days, in printing the Scriptures, and prayed that they might be protected from the loss which they would sustain if the Dutch printers undersold them. He urged, also, that the public would suffer from this act of piracy, "since it was like to prove a bad edition, both for paper and print, and exceedingly erroneous and incorrect; for that the printers were Dutchmen, who could neither speak nor write true English, and were generally so covetous as not to give sufficient encouragement to any learned men to oversee

and correct the press." He demanded that none should print Coverdale's Bible but himself for three years; and furthermore, that every curate should be obliged to have one copy, and every abbey six copies.

It would appear that the clergy did not approve of the existing versions of the Scriptures. They petitioned the king to order that a new translation might be made. Henry was induced to sanction the publication of a new edition, which is generally known as "Cranmer's Bible," and the "Great Bible." Grafton and Whitchurch were engaged to print it.

At this period Paris was famed for the excellence of its printers, as well as for the cheapness and goodness of its paper, and it was therefore determined to print the new edition of the English Bible in the capital of France. Grafton and Whitchurch proceeded hither, bearing letters from Henry, in compliance with which Francis I. gave them permission to proceed with the work. Miles Coverdale was engaged to correct the press, and proceeded to Paris, at the end of the year 1538. The work was proceeding prosperously, when the Inquisition, treating the king's license as waste paper, ordered it to be stopped. Grafton and Coverdale, and even some of the workmen, were summoned to appear before the Inquisitors, charged with heresy; but fearing imprisonment, and even death, they fled. The sheets already printed were then seized

and ordered to be burnt. The sentence was, however, frustrated in a curious manner. A haberdasher having seen the sheets, offered to buy them to use as wrapping paper for his goods, and the avaricious officer of the Inquisition sold them. Soon afterwards Grafton returned to Paris, supported by the authority of Lord Cromwell, bought the sheets from the haberdasher, and removed his types, presses, and printers to London. The work was completed in 1539, and was the first English Bible printed in England.

The "Great Bible," as this edition is called, follows Coverdale's version, revised, it is thought, by Archbishop Cranmer. Some of the copies contain a preface written by him, though it is asserted that it has been transferred from another edition, published a year later by Grafton. The title-page is adorned by a pictorial border, designed by Hans Holbein, descriptive of the incidents attending the printing of the Scriptures in the vulgar tongue. On the top, the Almighty is represented in the clouds of heaven, stretching forth his hands. Out of his mouth proceed two labels, one bearing the text, "The word that is departed from me shall not return to me again, as a vain word, but it shall effect that which I purposed;" the other label is inscribed, "I have found a man after my own heart who shall fulfil all my will;" and it points towards King Henry VIII., who is represented kneeling bare-

headed, and his hands lifted towards heaven, with his crown on the ground before him, and a label going out of his mouth saying, "Thy word is a lanthorn to my feet." Underneath the Almighty, the king is again represented sitting on his throne. On his right hand are two bishops bareheaded, and their mitres on the ground, betokening the king's supremacy over the Church. On his left hand are several of the lords temporal. The king is giving a book, inscribed, "The word of God," to one of the bishops, saying to him, "These things exhort and teach;" and another book, similarly inscribed, to one of the lay lords, saying, "It is my ordinance and decree that in my kingdom and whole empire all men tremble at and fear the living God." These texts, it may be explained, are written on labels which issue from the king's mouth, pointing towards the persons to whom they are addressed. Underneath the bishops stands Archbishop Cranmer, wearing his mitre and robes, and he delivers a third book to a priest who kneels before him, saying, "Feed the flock which is amongst you." Under the lords temporal stands Cromwell, the king's vicegerent in ecclesiastical affairs. His lordship is delivering a fourth book to a bareheaded nobleman, saying, "Depart from evil, and do good; seek peace, and pursue it." At the bottom is represented a congregation of persons of all ranks and qualities, orders, sexes, ages, men, women, and

children, priests, soldiers, tradesmen, and countrymen. A priest is preaching from a pulpit, and they are represented crying, "God save the king," to express thankfulness to his highness for granting them the privilege of having and reading the Holy Scriptures in their mother-tongue. On the left side some captives are looking through the prison gates, partaking of the great and common joy. All the speeches are in Latin, even those issuing from the children's mouths—a rather curious mode of commemorating the translation of the Scriptures from the Latin and Hebrew into the English language.

But scarcely had the Great Bible been printed, than the king's antipathy to its free use returned. Cromwell, who had encouraged the work, was beheaded in 1541; an attempt was made, though unsuccessfully, in 1542, to substitute the words of the Latin Vulgate for the plainer English expressions in the new versions; and the Parliament, deferring to the prejudices of the king, in 1543, prohibited the circulation of Tyndale's version, and, furthermore, forbade apprentices, journeymen, husbandmen, or any other servants, to read that or any version whatever, either in public or in private. Finally, Coverdale's version was forbidden in 1546.

Henry was succeeded in the following year by Edward VI., who loved the Scriptures, and removed the prohibition which had been placed

on their publication by his father. It is said that three swords having been borne before the royal boy at his coronation, he asked, "Where is the fourth?" The courtiers, having copied the usual form in conducting the ceremony, did not know what he meant. "I mean," he told them, "the Bible; that book is the sword of the Spirit, and to be preferred before these other swords. That ought in all right to govern us, who use the others for the people's safety by God's appointment. Without that sword we are nothing, we have no power; from that we see what we are to-day; from that alone we obtain all power, and virtue, grace, and salvation, and whatsoever we have of strength." In this spirit young Edward established the Church of England by law; he ordered divine service to be celebrated in the English tongue; he ordered the Common Prayer Book to be compiled; and he established thirty grammar-schools, which have ever since diffused the blessings of education over the country. Everybody might freely read the Scriptures, and no less than fifty editions were published in his short reign of six years and a half.

Queen Mary, soon after ascending the throne, however, prohibited the reading of the Bible in the churches, and the printing of the English versions of it. The followers of the Reformation were also persecuted, and the first person put to death was John Rogers, the

editor of Matthews' Bible. A great number of Protestants escaped from the kingdom, and took refuge at Geneva. Amongst these was Miles Coverdale, who seems to have devoted himself to the work of diffusing the Scriptures in the English tongue. He associated himself with John Knox and others, and in the year 1560 they printed what is called the *Geneva Bible.* This was the favourite version of the English Puritans and Scotch Presbyterians.

Queen Elizabeth ascended the throne in 1558, and, according to custom, on the morrow of her coronation set some prisoners at liberty. One of the courtiers seized the opportunity to present a petition, praying that some other "principal prisoners" might also be released. The queen inquired who they were? She was informed, "they are the four evangelists and the apostle Paul, who have long been shut up, as it were, in prison; so that they could not converse with the common people, who are eager to see them abroad." The queen evaded a direct reply, remarking that "it would be best first to inquire of the evangelists themselves whether they would be released or no." Soon afterwards, however, the reading and printing of the Bible was resumed by the queen's authority. Archbishop Parker, moreover, set about the production of a new English edition. He divided the Scriptures into portions, and distributed them amongst the bishops, who tested the accuracy of the

existing version by comparing it with the Hebrew and Greek versions. A great many alterations were made. This version was printed in 1568, in a large folio, and is called the Bishops' Bible. During the reign of Elizabeth, no less than 130 distinct editions of the Scriptures were printed in England.

The Church of Rome had maintained, until the reign of Elizabeth, that the common use of the Scriptures was dangerous to morals. Its reasons are thus set forth by a writer of that period: "It is not without very good reason that the Church interdicts the promiscuous and indiscreet and irreverent use of the Holy and Divine Psalms with which the Holy Ghost inspired King David. We ought not to mix God in our actions but with the highest reverence and caution. That poetry is too sacred to be put to no other use than to exercise the lungs and to delight our ears. It ought to come from the soul, and not from the tongue. It is not fit that a 'prentice in his shop, amongst his vain and frivolous thoughts, should be permitted to pass away his time, and divert himself with such sacred things. Neither is it decent to see the Holy Bible, the rule of our worship and belief, tumbled up and down a hall or a kitchen. They were formerly mysteries, but are now become sports and recreations. 'Tis a study too serious and too venerable to be cursorily or slightly turned over. The reading of the Scriptures ought to

be a temperate and premeditated act, and to which we should always add this devout preface, *sursum corda*, preparing ever the body to so humble and composed a gesture and countenance as shall evidence their veneration and attention. Neither is it a book for every one to handle, but the study of select men, set apart for that purpose, and whom Almighty God has been pleased to call to that office and sacred function; the wicked and ignorant blemish it. 'Tis not a story to tell, but a history to reverence, and fear, and adore. Are not they, then, amusing persons who think they have rendered it palpable to the people by translating it into the people's tongue? Does the understanding of all therein contained only stick at words? Shall I venture to say, farther, that by coming so near to understand a little, they are much wider of the whole scope than before? A total ignorance, and wholly depending upon the exposition of other and qualified persons, were more instructive and salutary than the vain and verbal knowledge, the nurse of temerity and presumption."

The demand for the Scriptures in the vulgar tongue, however, could not be stayed. The Church of Rome, therefore, determined to have a version of its own, under the sanction of the pope. The New Testament in English was published at Rheims in 1582, and it was followed by the Old Testament, printed at

Douay in 1609. This version is what is commonly called the Douay Bible. It is considered far inferior in plainness to the other English translations, as the translators have retained a large number of Hebrew and Greek words, for want, as it was alleged, of English words which would express the same meaning.

The next and last translation of the Bible was made in the reign of James I. The king considered that the English versions in existence were not so good as they might be, and determined to improve them. He designed to make—not, indeed, a new translation, nor to convert a bad translation into a good one, nor a good translation into a better translation—but out of many good translations to make the best. "I wish," he said at a conference with the clergy in 1603, "some special pains were taken for a uniform translation, which should be done by the best learned men in both universities, then revised by the bishops, presented to the Privy Council, and lastly, ratified by royal authority, to be used in the whole Church, and no other." In the following year the king appointed fifty-four learned persons to perform this work, and forty-seven soon afterwards engaged in it. They divided themselves into six classes, which acted quite independently of each other. Two of the classes sat at Oxford, two at Cambridge, and the remaining two in Westminster. Each

class had a separate portion of Scripture assigned to it for translation, and each member of the class made a separate translation of the whole portion. The several translations were afterwards revised, compared, and collated into one at a general meeting of the class. "They met together," says Selden, "and one reading the translation, the rest holding in their hands some Bible, either of the learned tongues, or French, Spanish, Italian, &c. If they found any fault, they spoke; if not, he read on." In this way every part of the translation passed through a number of ordeals varying from thirty to sixteen, according to the number in the company of translators. The translators generally followed the version of the Bishops' Bible; but they consulted the other English versions, and also the Hebrew, Greek, and Latin versions. When words had many different meanings attached to them, the translators adopted that one which was most commonly used by the ancient fathers of Christianity. The translation occupied three years, having been commenced in 1607, and it was printed in 1618. This translation is called King James's Bible, and it is that which is now used by all classes of Protestants in this kingdom. So superior is it to the other versions, that on its publication they fell into disuse. Some portions of the earlier translations are, however, still retained by the Church of England; for instance, the

Psalms in the Book of Common Prayer are Miles Coverdale's version.

"The English translation of the Bible," says Selden, "is the best translation in the world, and renders the sense of the original best." This happily is the translation which has been most widely diffused. Great missionary societies have collected money, and trained devoted men to distribute it throughout all nations, "as the waters cover the sea;" and first and foremost are the Societies for Promoting Christian Knowledge, and for the Propagation of the Gospel in Foreign Parts. Our ships have carried the Scriptures "far as the breeze can bear the billows' foam." Our missionaries have penetrated into the strange places of the earth, finding in it a guide and a comforter, impregnable armour against the spoiler, and the most precious gift to all nations. Since the time when Eliot, the sainted "apostle of the Indians," translated the Scriptures into the native tongue of North America, the work of translation has gone on until there is not a language, and scarcely a known dialect, in which they are not read. Languages have been reduced to writing for the first time, alphabets have even been invented, in order that the heathen may read, mark, and learn the Holy Volume. The day is fast approaching when the gospel will be preached, as Christ commanded, to every creature. The greatest human instrument has been the Printing Press.

Printing for the Blind.

Printing has enabled even the blind to read. This is one of the noblest triumphs of the invention. Consider what blindness is. It is to see nothing of creation, which is beautiful because God has pronounced it good. It is to see nothing of the sun, and all the colours with which it paints the sky—the pure tints of sunrise, the golden blaze of noon, and the gorgeous hues of sunset. To the blind, the brightest light and the deepest shade are the same; the rainbow created in the heavens as a sign of mercy is no sign at all. Blindness is to see nothing of the lofty and impressive sky, of the clouds which fill it with the images of a thousand forms—mountains white with snow, islands floating in green and purple seas, castles perched on cliffs; to know nothing of the birds which people the air with life; of the silvery moon which prolongs the day, and the myriads of stars which render the darkness of night beautiful. The blind man has no true notion of anything which he cannot touch, or of any space which he cannot measure with his hand or foot. Lovely scenes, noble ships, magnificent buildings, great bridges, are beyond his knowledge; for he cannot feel them as the blind patriarch Isaac felt the face and hands of Jacob. The universe is annihilated to him. The book of

Nature, with all its pictures of beauty, is closed to him. He lives in a cloud of thick darkness. The world is his prison. He cannot even see the face which smiles upon him. Such is the inexpressible misfortune which has overtaken those from whom God withholds his first and greatest gift to the world—light.

But He has tempered the wind to the shorn lamb. Even blindness has its blessing. The attention of the blind is not distracted by surrounding objects; their minds are concentrated in thought, and are strengthened by thinking. As they cannot trust their eyes, the senses which they possess learn to do the work of eyes. The sense of sight, it has been said, is not destroyed, but is added to the other senses. The hearing of a blind man becomes so acute that he can recognize a friend by his breathing. His touch becomes so exquisitely fine, that he can feel the air, and discover by its greater or smaller resistance, whether or not he is approaching any object which may hurt him. His fingers become wonderfully clever, and these have been taught to act as eyes, and not only read, but print.

Fifty years ago a blind lady, named Parodis, excited much public interest at Paris, by the beautiful manner in which she played on the pianoforte. The facility with which she distinguished the different keys surprised everybody. It occurred to one of her hearers, M.

Haüy, that as this blind lady could distinguish keys with her fingers alone, other people might be taught to distinguish the letters of the alphabet in the same way. He, therefore, matured a plan by which the blind could not only print letters but read them. The printing was effected in this way. The blind man was furnished with a case of type, containing, of course, every letter of the alphabet, and he composed the letters into the words which he wished to express. Then taking a sheet of stout paper moistened, he laid it on the type and pressed it until an impression of the type rose on the upper side of the paper, so high above the surface, that the letters and words could be felt and traced by the fingers. At first the plan was employed for expressing the thoughts of the blind to the blind, but it is now much used for printing the books used in educating them. They are taught arithmetic, algebra, and music by means of embossed characters. The Bible and many other books have been printed, and, at one time, there was even a magazine published for the use of the blind; its contents were fragments of the best authors, poetry and anecdotes. The expense of printing books for the blind is, unfortunately, heavy, owing to the size required that their embossed letters may be distinguishable. The attempt to reduce the cost has led to the introduction of several systems, and these, in curing one evil,

have created another more serious; for it has led to the use of several different systems, instead of one general system, which could be read by all the blind. Five systems are practised in England, and as the blind are only taught one of them, four-fifths of the books published are useless to them. In America only one system is tolerated, the ordinary letters are used, and it is the cheapest, if not the best, of all the systems.

The existence of the blind has, in this way, been completely changed. They no longer doze away their existence in a sunny spot during the summer, and in a chimney-corner during the winter. They are no longer tormented by a sense of dependence and helplessness for want of employment for their thoughts as well as of their hands. Nor is their daily course a mere change from labour to idleness. After they have earned their daily bread by the work of their hands, they are able to read, and first and foremost in the library of the blind is that blessed Book, the interest of which is exhaustless, because it is not merely a narrative of wonderful events, but the bread and water of eternal life. And thus blindness is converted into a blessing. God, in dimming the eye of the body, has sharpened the eye of the soul. It is said, that Democritus, a heathen philosopher, put out his eyes, that he might devote all his attention to thought. So God, in afflicting

his creatures, has destroyed the sin of the eye, and strengthened the longing for that which "eye hath not seen, nor ear heard, neither have entered into the heart of man, the things which God has prepared for them that love him."

Amongst the wonderful things which formed the Great Exhibition of 1851, were some beautiful baskets which obtained a medal. They were the work of a little girl, deaf, dumb, and blind. Think what printing has done for this poor child by enabling her to "read, mark, learn, and inwardly digest" the Holy Scriptures. She has never been encouraged by "that arrow of the heart," a sweet voice; she has never been gladdened by the smile of father or mother, sister or brother; she is amongst human beings no more than the giraffe amongst animals—she is even more helpless, for she has not the expressive beseeching eyes with which it sometimes obtains mercy from its enemies. Deaf, and unable to hear the voice of a teacher; dumb, and unable to utter the sounds of life; blind, and unconscious alike of the wing which shelters her head, and the pitfall beneath her feet; yet, lacking eyes, ears, and speech, God has enabled her to use her fingers as eyes, ears and tongue as sight and as sound, as teachers and as workers. Sight, hearing, and speech being taken away, touch is strengthened in the direct proportion of the loss. In this

way the blind girl of Pompeii found a blessing in her calamity; for while the other inhabitants perished, confounded by the thick palpable darkness with which the sky was filled by the clouds of dust thrown out from the fiery crater of Vesuvius, she readily found her way to a place of safety, because her footsteps had never been dependent on the light. It is a sweet picture to see the poor little creature spoken of, in her home with the blind Bible spread upon her knees, feeling the consoling words of God with her fingers, and then in her heart—feeling her way to Heaven. If the discovery had done no more than rescue this child from the world of darkness and silence, it would still have deserved to be called "The noble art of Printing."

Engraving.

To render an account of the Art of Printing complete, it is necessary to describe, however briefly, the different modes of engraving. An engraving is, in truth, to scenes and figures, what letters are to words and thoughts —the representation of them. As words represent impalpable ideas, so engravings represent palpable objects. Words are the impersonation of the one, and engravings of the other. Just as by words the minds of great men are made visible to those who know not the persons, so by engravings the distant parts

of the world are brought home to those who have never visited them. Printing describes in words skies flooded with sunshine, or darkened with clouds; seas smooth as glass, or roughened by the tempest; awful cataracts, or sweet-toned brooks. Engraving presents images of them; and both are branches of one art.

There are different kinds of engraving; but before specifying them, we shall describe the mode now most commonly practised. The first thing done is to trace the design to be engraved with a pencil on a piece of thin paper; and the copper or steel plate on which it is to be engraved, is covered with a composition of wax, asphaltum, gum-mastic, and rosin, and called the etching ground. This is laid on hot in a liquid state. When the etching ground has been sufficiently hardened by the air, the paper bearing the outline of the design is laid upon it, face downwards, and the whole is then pressed in a rolling press, the result of which is that the pencilled outline is transferred from the paper to the etching ground. The lines of the design are then cut on the etching ground with etching needles, which are similar to common needles, except that they are fixed in handles. The strokes are cut through the etching ground until the plate is laid bare. The next operation is to make a bank of wax all round the edge of the plate, so that it is converted into a trough. Then aquafortis is poured upon the surface, and the acid sinking

into the lines traced by the etching needles, corrodes the plate beneath. Thus all the parts which are not covered by the wax are *bitten in* as it is called. The acid is poured off when the design has been bitten in, the etching ground is melted off, and the engraving is ready for printing. But it is now usually touched over with a burin or graver. This instrument is shaped according to the character of the line it has to cut. Square gravers are used for cutting broad lines, and lozenge-shaped gravers for more delicate lines. In cutting a line, the graver is held almost horizontal and forced forward. A scraper is also used to scrape off the metal or burr ploughed up by the graver as it passes along the face of the plate. Rembrandt, the great painter, used, however, to leave the burr on his etchings until it was worn away in printing, which soon occurs. It added greatly to the effect; and impressions from his works with the burr on are highly valued.

The above mode of engraving is a combination of two processes, *etching* and *dry point*. Etching consists in strokes cut through the etching ground and afterwards bitten into the plate with acid. Dry point consists in cutting with a point or needle, without the ground, on the plate itself. The first is the easiest mode of engraving, but the second is still retained where great exactness and regularity of the lines are required, as, for instance, in

the execution of portraits, where everything, the most minute, must be expressed according to the original design. For this the graver is most effectual.

Engraving in mezzotinto is very different from line engraving. The surface of the plate to be engraved is first hacked all over with a tool like a chisel, having a toothed edge, called a cradle or *grounder*. By rocking the cradle to and fro in many directions the plate is roughened or barbed with what is called the mezzotinto ground. If an impression were taken from the plate whilst in this state, the paper would be covered of a deep black colour. The mezzotinto ground having been laid, the artist goes to work upon it. In some cases the design is etched before the ground is laid; in others, it is merely drawn on paper. The artist, guided by one or the other, scrapes away the ground from all those parts which are not intended to be perfectly black in the impression. In proportion to the light or shade to be represented, he scrapes away more or less, and with another tool called a burnisher, obtains that perfect whiteness which is sometimes required, as in the forehead, the nose, and the linen of a portrait. The advantage of mezzotinto engraving is in the facility with which it is executed as compared with line engravings. It is, of course, easier to scrape or burnish away parts of a dark ground corresponding with a design sketched on it, than it is to form

shades on a white ground by an infinite number of delicate strokes made by the graver. The grand difference between mezzotinto and the other modes of engraving is this:—in mezzotinto the artist works from dark to light, whilst in the others he works from light to dark; in other words, in the one he cuts away the surface to make light, and in the other he cuts into the surface to make shades.

The invention of mezzotinto, so the story runs, arose from accident. Prince Rupert, it is said, was watching one of his soldiers cleaning a gun. The soldier had kept guard during the night, and the dew had rusted his weapon. One patch of rust, the Prince thought, bore the resemblance to a figure; it seemed as if the gun had been engraved by the night air. It struck the Prince that by corroding or grinding a plate all over, he might afterwards scrape away a design from it, from which engravings might be printed. He tried the experiment, and succeeded. There are some mezzotint engravings by Prince Rupert still in existence, and it was long thought that they were the first examples of the style. But it would appear that even if the Prince did discover the art of mezzotinto, there was an earlier discoverer of it. This was Louis Van Seigen, a colonel in the service of the Landgrave of Hesse-Cassel, and it is probable that the Prince learnt the secret from him. Certainly Seigen called himself the inventor

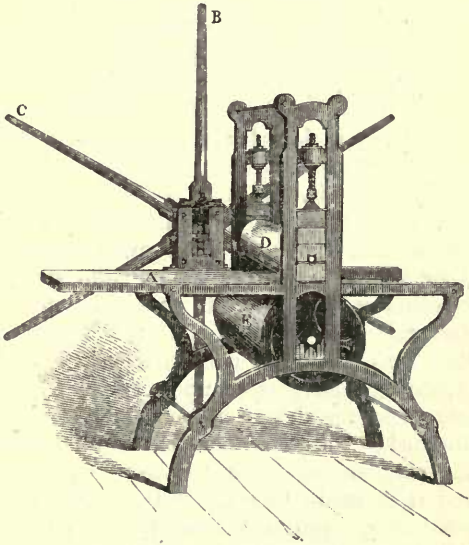
of it in Prince Rupert's life-time, though the fact had escaped notice until recently. Moreover, proof exists in support of his claim. There is in the British Museum a portrait executed by Seigen in 1643, that is, fifteen years earlier than the engravings by the execution of which Prince Rupert obtained the credit of the invention.

Engraving is also effected by photography, that is, by means of the sun. A steel plate is covered with a coating of isinglass mixed with some bichromate of potash and water, which serves, when dry, as an etching ground. It is then ready for receiving the photographic image of any object. Supposing the object to be engraved is a piece of black lace, it is placed upon the plate in a photographic copying frame, and they are screwed together in close contact. The frame is then placed in the direct light of the sun, and at the end of a minute or two, on the plate being taken out, it is found to be impressed with a yellowish image of the lace upon a brown ground. These colours are owing to the bichromate of potash. The plate is then washed with cold water, which dissolves all the bichromate, and nearly all the isinglass, from those parts of the plate which have been veiled from the sun by the lace, that is, from the photographic image, while it dissolves little or none of the isinglass that has been exposed to the sun; and the consequence is that, instead of the

yellow image, we have now a white one, but still on a brown ground. The plate is next dipped in alcohol, and afterwards dried; and it now appears impressed with a beautiful white image, raised above the level of the surface. The image of a piece of black lace, indeed, appears like a piece of very delicate white lace, of a similar pattern, closely adhering, and raised above the polished surface of the plate, and is often so beautiful that the operator feels reluctant to destroy it, to continue the process of engraving. The etching is performed by pouring bichloride of platina on the plate; it bites into the surface of the plate, turning the image black. On the completion of the biting-in the gelatine is removed with a sponge, and it is then seen that the image has been etched, and is fit for printing.

The plate having been engraved by either of these processes, it is printed at a rolling-press. The method of printing is as follows:—The workman takes a small quantity of a peculiar kind of ink, on a rubber made of woollen rags, and having inked the plate sufficiently, he wipes it clean again, taking care, however, not to wipe the ink out of the sunken parts or lines of the engraving. The plate is then laid on the bed or plank of the press, A, upon the plate is laid the paper which is well moistened, and upon the paper again are laid two or three folds of fine cloth or blanket. The arms of the cross, B C, are then turned, and this move-

ment turns two rollers, one of which, E, is under the level of the bed with the plate, and serves to roll it in under the upper roller D.



The plate is pinched very strongly between the two rollers, the moistened paper is pressed into the strokes of the engraving, and soaking out the ink, becomes impressed with a copy of the design.

A copper-plate will yield 1,500 impressions before it sustains any injury from the pressure. The earliest impressions are called proofs, being

the best. When the plate begins to wear, it is touched over with a graver. Five thousand impressions can be obtained from a copper-plate, but 50,000 impressions may be obtained from a steel plate, as it is far more durable.

Steel engravings are also used for printing on steel. The process is called *siderography*. A thick plate, or block, of cast steel is made hot until it is decarbonized, or converted into a very pure soft iron. The design is then engraved on it, and this is done with great ease when the plate is thus softened. The hardness of the plate is again restored, in other words, it is reconverted into steel, by exposing it alternately to fire and water. A steel roller, softened in the same way as the plate was, is rolled over the surface of the engraving, and pressed upon it with so much force that the design becomes embossed upon the surface of the roller. The roller is now hardened in the same way as the plate was, and it is made to transfer the design to any number of softened steel plates by being rolled over them; these plates are hardened in turn, and used in printing the design on paper. An inconceivable number of engraved plates can thus be obtained from a single plate engraved by the hand. If the roller should be worn out in multiplying them, another roller can be made from the original plate. It is in this way that the Queen's heads used as postage and receipt stamps are

printed. Only one head is engraved by the hand, but it has been multiplied in some instances 6,000 times on the surface of a roller. From this roller, sheets of heads are printed. As many as 500,000 impressions have been obtained on paper from one plate strongly engraved. Bank-notes are generally printed by this process.

Siderography has led to what is called Natural Printing, by which a representation of any flat object can be printed from the object itself. A piece of delicate lace, for instance, is placed on a sheet of polished copper and a sheet of soft lead, the whole is forcibly pressed together, and thus a perfect impression of the lace is obtained on the soft lead. This may either be used in printing, or as a mould for making casts of a harder material. By this mode the leaves of plants, branches, flowers, feathers, wings of birds, and other substances, may be printed with astonishing accuracy; even the fibres of plants and bones of animals are delineated so naturally, that it is almost impossible to believe, that the representations are not the things themselves. Objects too brittle to bear pressure, it may be added, are printed by means of gutta percha; the gutta percha is poured over them in a liquid state, like plaster used in stereotyping, and when dry it forms a mould for casts from which the objects are printed.

Lithography.

Another kind of printing remains to be described. This is Lithography, which may be called printing with grease. It is usually called Chemical Printing, because the impressions are obtained, not by cutting strokes into a surface as in engraving, or raising strokes on a surface as in block and letter printing, but from a smooth surface, through the chemical affinities which certain things have for each other.

A slab of calcareous slate stone is made perfectly smooth, and the artist draws on it the design which he proposes to print. He draws it either with lithographic chalk, or lithographic ink, both of which are made of tallow, virgin-wax, soap, shellac, and lampblack. The only difference between them is that the chalk is used dry, and the ink wet, being laid on with a brush. The drawing would disappear if it were rubbed over with a wet sponge, in consequence of the soap contained in the drawing materials; and, therefore, a weak solution of nitrous acid is poured over it, and this, neutralizing the soap, prevents it from dissolving in water. The stone is afterwards washed with a solution of gum, and after this is removed, it will always be found that the drawing has been rendered capable of resisting water. The design is now ready for printing, which is effected in this way :—A few drops of water are thrown on the stone, but they only soak into those parts of the

surface which are not touched by the drawing; the drawing itself being greasy repels the water, and remains perfectly dry. A roller covered with printing ink is now rolled over the stone, but the ink being composed partly of oil, the parts of the stone wetted with water will not receive it, as oil and water will not unite. But the drawing being greasy, will receive the ink—it is grease to grease – and, therefore, the ink passes from the roller to the drawing. Moistened paper is now laid on the stone, the whole is passed through a rolling-press, just in the same way as an engraving, the ink is transferred from the greased drawing to the paper, and, in fact, the drawing is printed. By continuing to wet the stone, and ink the drawing, an almost unlimited number of impressions may be obtained. Strange as it may seem, it is the grease which prints. The lampblack, used in making the lithographic chalk and ink, only serves to enable the artist to judge of the quantity of grease laid on the stone. That it does not help to print has been proved by a curious phenomenon. The design is often washed out with turpentine in the progress of printing, at least it disappears so entirely that persons unacquainted with the subject might suppose it was utterly destroyed. But in reality it is only the lampblack which has been washed away. The grease remains, though it has become invisible; and on the ink being rolled upon it, reappears uninjured.

There are various modes of lithography, but this one will give an idea of the whole. Transfer lithography, however, deserves especial notice from its great usefulness. A thin paper called transfer paper is prepared by washing one side of it with a liquid gum. The writing or drawing to be lithographed is then written or drawn on this side of the paper, which is laid on a polished stone. The back of the paper having been wetted, the stone and paper are pressed in a rolling-press, and by the pressure the writing or drawing is transferred from the paper to the stone. The printing is then effected in the manner already explained. This mode of lithography is much used in commercial offices, to save the trouble of multiplying copies of letters, and also in the government offices, as thereby one written despatch may be multiplied at pleasure without delay, or the danger of mistake.

Lithography is also used to print from copper-plate engravings. An impression is taken from a copper-plate engraving on unsized paper, and transferred to a stone by passing it through a rolling-press. The copy is then made durable by applying acid, and printed in the manner already described. Impressions thus obtained are almost as good as those printed directly from the copper-plates.

The anastatic process of lithography, which has just been patented, is the most valuable extension of the art, since it has all the advan-

tages of ordinary letter-press printing. By this process, drawings made by lithographic ink on common drawing-paper, or by lithographic chalk on granulated paper, as well as old impressions of copper plates, lithographs, woodcuts, and letter-press printing, can be easily transferred to zinc, and printed from by steam. Until the discovery of this process, the application of steam or other machinery to lithography had been considered impracticable. The mode of transferring a drawing to zinc is exceedingly simple. The back of the paper on which the drawing is made, is washed with dilute nitric acid; the drawing is pressed upon a plate of polished zinc, and the same pressure transfers the ink of the drawing to the zinc, and expresses the acid through the paper; the drawing, therefore, requires no further preparation for printing, though phosphatic acid is applied in order to prevent the ink from spreading to the blank parts of the plate, those parts, we mean within the lines of the drawing, which are to be left white. The zinc plate is rolled round the cylinder of a press, and the plate is moistened and inked during its revolutions by a series of rollers. In this way the print of a newspaper can be transferred to zinc, the zinc may be used instead of types, and be printed as rapidly as the newspaper itself is thrown off at the ordinary printing machine.

The most interesting use of lithography is in multiplying the sketches and drawings of

artists. Any one who can draw on paper, can draw just as well on stone, with very little more trouble. Thus an artist may use the original sketch, as the type for printing copies of it. Lithography is also used for printing pictures in colours. The process is simple and easy, though as many different stones must be used as there are different colours in the picture. The original drawing is transferred to a stone, and the lithographer then draws upon the stone with ink the whole of the outline of the subject, and as much of the shading as he thinks necessary. The printer next prints from the stone as many impressions as there are colours or tints in the picture; and these impressions are used to transfer the outline to the other stones which are to be used. Every stone is thus furnished with an outline of the whole picture, though it is to be used for printing one colour or tint only. The artist then indicates on each stone in black ink the requisite amount of colour. Each colour is printed in succession, the first stone giving the outline and the black parts, the next, the red parts, a third, the yellow, and so on until the picture is completed. The chief difficulty in printing impressions from several stones upon one sheet of paper, was to bring each colour exactly in its right place, without either overlapping and producing dark edges, or leaving white lines and gaps between each colour; this is now effected by a simple apparatus fixed on the press which prevents

the paper from shifting a hair's breadth. The productions of Chromo-lithography, as the process is called, are very beautiful. "To look at *Apple Blossoms* in chromo-lithography," said the *Athenæum*, in February, 1854, speaking of a lithographed copy of a picture, "is almost to anticipate the 'blossom month,' as the Saxon poets called May. Within the last few years lithography has passed from woolly inky landscapes, to the most accurate imitations of water-colour drawings and even oil-paintings. We can now have not only mono-chromatic engravings of the masters we esteem, but artistically coloured fac-similes. This is another step to bring Art within the reach of even the mechanic, and when it arrives at the poor man's house, its real mission of refinement and elevation will have begun. We have here a small apple-bough, loaded thick with rosy flowers, trailing down over a mossy, sandy, crumbling bank, rich in warm ochreous tints; in the foreground lies the nest of that most skilful of all our winged architects, the goldfinch. The globular buds, the flowers red and white, with the neutral tinge blending both colours, the cottony down on the twigs, and the little rusty lichens that encrust them, are admirably conveyed. With equal effect are given the entwining sprays of the bird's nest, the mossy cup where the spotted eggs lie soft, and the few feathers plucked from the mother's own breast, that make the cradle

more dainty, not to forget the little root fibres that net it round, some of which have broken loose like osiers from an old fishing creel."

The invention of Lithography is another of the wonderful things which have resulted from accident. Alois Senefelder was the son of an actor at the Royal Theatre at Munich. His father designed to make him a lawyer, and placed him at the University of Ingoldstadt as a student of jurisprudence. Deprived of resources, however, by his father's death, he became an actor, but utterly failed. He then turned author, but he could not publish his books for want of money. He then determined to be his own printer; but how could this be accomplished? Not by ordinary means, for Senefelder was too poor to buy types and a press; and he therefore resorted to extraordinary means. "Necessity is the mother of invention," and he tried to invent a substitute for letter-press printing. His idea was to write on copper-plates with some kind of composition which would give an impression like types. He found, after repeated experiments, that a composition of soap, wax, and lampblack formed a capital ink for writing on a copper-plate, and became as hard as lead. The next step was to write some words with the composition, to ascertain if an impression could be obtained from it. The words it was necessary of course, to write backwards, and this presented another difficulty. But "practice makes

perfect," and Senefelder used some soft stone as the cheapest material on which he could learn to write backwards. One day whilst practising, his mother desired him to take an account of some linen which she was about to send to be washed. Having no paper at hand —having, in truth, exhausted every slip, and drained his inkstand, he wrote the account on a stone with his composition ink, intending to copy it at his leisure. Afterwards, when he was about to efface the writing, it struck him that he might obtain impressions from it; and having bitten away the stone with acid for about the hundredth part of an inch to elevate the writing, he found that he could charge the lines with ink and take impressions from them. Stimulated by this success, he persevered in his experiments; he discovered that it was not necessary to lower the surface of the stone below the writing, or, in other words, to raise the writing above the surface of the stone, as the chemical principle by which grease and water are kept from uniting would answer the purpose. He had, in short, discovered the principle of Lithography, and it only remained to improve its practice. Senefelder set to work with renewed vigour to discover a better composition than he had used, though without any settled plan, trying the first thing that came to hand, and trusting to chance for aid. His progress was retarded more by ignorance than by any diffi-

culty, inherent of the art. He frequently wasted months in surmounting impediments which a little knowledge would have removed —another proof that whatever a man's profession may be, all kinds of knowledge may become useful to him. But the very difficulties created new successes. Thus, being clumsy in writing backwards, Senefelder hit upon the mode of transfer, which is one of the most useful features of the art.

Senefelder now determined to earn his livelihood by the use of his invention. But, then, he had no money to construct a press, and purchase printing materials. A lucky thought struck him. One of his friends had been selected as a soldier; but as the recruit disliked the army, he was willing to give 200 florins to any one who would take his place. Senefelder determined to become his substitute, and serve the term of duty, and, then, if he were not killed, commence printing with the money. "I was quickly resolved," says Senefelder; "and on the third day after forming my resolution, I went to Ingoldstadt with a party of recruits to join my regiment. It was not without some feelings of mortification and humbled pride that I entered the city in which I had formerly led the life of an independent student; but the consciousness of my own dignity, and enthusiasm for my new invention, greatly contributed to raise my spirits. The next morning I was to enlist; but to my great

disappointment, the commander of the regiment discovered that I was not a Bavarian; and, therefore, could not serve in the army without a special licence. Thus, my last hope failed me, and I left Ingoldstadt in a state of mind bordering on despair. As I passed the great bridge over the Danube, and looked at the majestic river, in which I had been twice nearly drowned while bathing, I could not suppress the wish that I had not been then saved, as misfortune seemed to persecute me with the utmost rigour, and deny me even the least prospect of gaining an honest subsistence in the military career."

But Senefelder's journey was not in vain. Gleisser, a military band-master at Ingoldstadt, was preparing some music for publication when Senefelder marched into the city with the recruits. The latter suggested that the music might be easily and inexpensively printed by his process; and Gleisser ultimately instructed him to prepare the stones, and set about it.

The first specimens of lithographic printing, then, were the words and notes of some songs, published in the year 1796. The Sovereign of the country was so much pleased on seeing the specimens, that he sent Senefelder 100 florins, and gave him the privilege of exercising the art exclusively in the Bavarian dominions. The Academy of Sciences, however, regarded the invention in a less favourable light. Senefelder laid his first work before the Academy, with an account of the process of lithography.

Instead of making any honourable mention of it, they sent the inventor 12 florins, with an intimation that, as the cost of the work was 6 florins, twice that sum was an ample reward!

Three years afterwards Senefelder took out patents at Paris, Vienna, and London, securing to himself the art of *polyautography*, as he styled it, and came to London for the purpose of practising it. The principal English artists tried it but without success, through the want of proper materials and imperfect knowledge, in addition, perhaps, to the crude state of the invention. Not only was the invention condemned in London but at Vienna also; and Senefelder returned to Munich, discountenanced and discomfited. But in 1806, M. Mittinger, Professor of Drawing in the public school of that city, succeeded in doing that which Senefelder had failed to accomplish. He invented the chalk drawing composition now used, and was thus enabled to multiply copies for his pupils with so much ease and beauty that the invention from that time became triumphant. The Bavarian government formed a lithographic establishment; and Senefelder having been placed at its head, executed a complete map and survey of Bavaria. Yet it was not until 1815 that the art came into use in France and England, though it is now extensively practised in both countries. In one London establishment alone, that of Messrs. Day and Sons, 200 artists, draughtsmen, and printers are constantly em-

ployed; and there are generally 800 tons of stones on the premises, some of the larger ones costing sixpence a pound. These stones are kept in an apartment jocosely called the "Quarry," and are arranged in niches, numbered and catalogued, after the manner of a well-ordered library. The visitor seems to be amongst the tombs of Etruria or Thebes. The stones used by lithographers are obtained from Germany, chiefly from the oolitic formations on the banks of the Danube and Iser in Bavaria.

Paper.

An account of printing would be incomplete, without a description of the material chiefly used in printing.

The word *paper* is derived from *papyrus*, the name of an Egyptian plant, the leaves of which were used for writing upon previously to the invention of paper. The French, German, and Spanish words for paper have a similar origin. The Italians use the Latin word *charta*, the ancient word for parchment and other writing materials.

The papyrus is a water plant growing from five to six feet high, and, having a triangular stem, one of which, says Bruce, is constantly opposed to the current of the stream in which it grows, as if to break its force. It was the thin concentric coats that surrounded the stem, like so many coats of bark, which were anciently used for writing upon. These coats

were cut into strips of a certain length, and placed side by side on a board ; another layer of strips was pasted over them crosswise ; and thus a sheet of convenient thickness was formed. The sheet was pressed smooth, dried in the sun, and polished with a shell, or some other smooth and hard substance. It was then fit for writing upon. All the records found in the tombs of Egypt, Etruria, Pompeii, and under the ruins of Nineveh, are written on papyrus.

Papyrus was one of the chief articles of Egyptian commerce. It was exported to Greece, Rome, and many other states, both in Europe and Asia. So great was the consumption, that it became very scarce and dear at Rome during the first century ; and a tumult arose, as bread riots do in our days, from exasperation caused by this scarcity. It soon afterwards became so scarce, even in Egypt, that Ptolemy Epiphanes forbade his subjects to sell it to foreigners. This led to the use of parchment instead of papyrus. The world owes the invention of parchment to Eumenes the Second, a learned king of Pergamos, in Asia Minor ; and it is thought that its name is a corruption of *pergamena*, the Latin name of Pergamos. It is made of the skin of sheep or lambs ; the finest, smoothest, and whitest kind, called *vellum*, is made from the skins of very young calves. The skin is stripped of its wool or hair, and placed in a lime-pit, and is thus thoroughly

cleansed. It is then stretched on a square wooden frame by the means of wooden pegs, scraped with a blunt iron tool, and made smooth; and pounded chalk and pumice-stone having been rubbed over it, the parchment becomes fit for use.

The ancient parchment seems to have been very fine. Pliny says that Cicero saw Homer's *Iliad* written on a piece of parchment so thin and flexible that it was enclosed in a nut-shell. The excellence of parchment diminished as time advanced. The sheets made in the seventh century, for instance, were very strong and good; and many books written at that time are still in existence. The sheets made in the eleventh century were inferior; the writers had, in truth, become accustomed to make the parchment on which they wrote, and made it badly. The antiquity of old books is now tested partly by the quality of the parchment on which they are written. The older the book is, the better is the parchment.

The cost of parchment has been so considerable from the earliest time, that the practice grew up of writing upon it over and over again, just as schoolboys use their slates. The old writing was rubbed out with pumice-stone, and the parchment written on anew. The skins so treated are called Palimpsest Manuscripts. In many cases, the ancient writing was not entirely obliterated, and a

careful examination of some of them has been rewarded by the discovery of several works and fragments of the ancient writers. A treatise written by Cicero, "De Republica," was thus discovered at Rome. A Commentary on the Psalms, by St. Jerome, had been written over it. Another of the books, thus restored to the light, is the "Institutions" of Gaius, the earliest attempt to present a sketch of the Roman law in the form of an elementary text-book. The manuscript of the latter, which consisted of 127 skins of parchment, was found in the Chapter-house of Verona as late as the year 1815. The original writing had in some parts been scrubbed out; in others, washed out; and the whole had been written over with the epistles of St. Jerome. The lines of the first and second writing both run in the same direction, sometimes covering each other; and 63 sheets had been written upon three times. The first writing was the book of Gaius; the second, a theological work; and both of these had been erased in turn, that the work of St. Jerome might be written. The task of deciphering the text of Gaius was, of course, very difficult. But what is there that patience will not effect? Some German scholars succeeded, after labouring many years, in attaining an exact copy of the book written by Gaius, and thus made a valuable addition to the knowledge of Roman law,

which is the foundation of much of the modern law.

Paper is produced from linen, cotton, and hempen rags, wheat straw, and the sweepings of cotton-mills, reduced to a pulp, and dried in sheets. Small quantities have also been produced from the inner bark of trees, the stalks of the nettle, the tendrils of the vine, the bine of the hop-plant, wood shavings, and other fibrous matter. Paper was invented in China nearly 2000 years since. The Chinese had been accustomed to write with a sharp-pointed instrument upon pieces of bamboo and plates of metal. A mandarin, however, boiled some hemp and bark of trees together until they were reduced to a paste, with which he formed paper. Chinese paper is now made chiefly of the bamboo reed, and is smoother and softer than European paper; some of the sheets are thirty and forty feet long. The art was carried from China to Persia about the year 652, and from thence it reached Arabia in 706. The Arabs substituted the cotton of their own growth for the materials used by the Chinese; and introduced the improved manufacture into Spain at the beginning of the eighth century, when they conquered that country. The Spaniards abounded in linen, and this led to another change of material—linen rags being used instead of cotton. From Spain a knowledge of the invention passed into France in the year 1260; into Germany in 1312; and into

England in 1320. Fuller, who lived between the years 1600 and 1650, says, that in his time "the paper bore the same character as the people of the country in which it was made; the Venetian paper being neat, subtle, and court-like; the French, light, slight, and slender; and the Dutch, thick, corpulent, gross, and spongy."

Until the year 1500, the paper used in England was obtained from France and Holland. About that time, one Tate established a paper-mill at Hertford; and in 1588, a German established another at Dartford, Kent. Queen Elizabeth, regarding the latter as a public benefactor, made him a knight. Paper-making did not thrive in England during the next two hundred years; little beyond coarse mapping paper was made. The first maker of fine writing-paper was Whatman. He had worked in some French mills as a journeyman, and, in 1770, commenced paper-making on his own account in Kent.

The first operation in a paper-mill is to sort the rags; the finer quality of linen and cotton for writing, drawing, and plate-papers; the seconds, of linen, cotton, and hemp, are used in the various qualities of printing-papers. Woollens are useless for paper-making (except for filtering purposes), and are generally sold for manure for hop-land; old cordage and tarred rope for millboards, brown, and wrapping papers. The rags are cut into small pieces by women, then boiled,

and transferred into a cistern fed with a continual supply of the best spring-water, and containing a roller furnished with a large number of sharp knives or teeth, which cut or bite against others fixed beneath the roller. The rags are forced again and again through these cutters, and, in a few hours, are cut to atoms, and, in fact, become a mere pulp, resembling milk. A quantity of chloride of lime or of chlorine gas is now mixed with the pulp; and as the chloride possesses the property of destroying all vegetable colours, the pulp is rendered quite white. This part of the process requires great care; for if the bleaching ingredient is not completely washed out the paper will be rotten, while the ink used in writing on it will turn brown, and even disappear altogether. The paper made before the use of chloride was of very bad colour, brown rather than white, and it was customary to give it a blue tint that the fault might be disguised. The bleaching having been effected, the pulp is ready for being made into paper. This is done both by the hand and by machine. If by hand, the pulp is placed in a large vat, made hot by a stove or by a steam-pipe, and kept continually in motion, in order that the fibrous matter may not sink in a sediment at the bottom. The paper is made in a mould formed of a piece of wire-cloth stretched on a square frame, and a thin cover of wood fitting closely upon it. The object of the wire-cloth

is to receive the pulp, while the wood frame prevents it from escaping at the sides, and limits the size of the sheet. The workman plunges the mould down obliquely into the pulp, and then raising it to a level, dips up a sufficient quantity to make a sheet of paper. He lays the mould on the side of the vat, lifts the cover, the water escapes, and the pulp arranges itself on the wire-cloth, and in two or three seconds becomes formed. A second workman now takes the mould, removes the sheet of pulp now become paper, which he places upon a piece of woollen cloth or felt, and then returns the mould to his comrade. The first workman, in the meantime, has made another sheet with another mould which has been placed on the side of the vat, ready to be treated in the same way as soon as the first mould is returned. The sheet is placed on the other sheet, being separated from it, however, by a felt; and thus the workmen go on, laying sheet on felt and felt on sheet, until they have made a *post;* this is a pile of six or eight quires, and its completion occupies half-an-hour. The post is now placed in a vat press and squeezed to force out the superfluous water, as well as to flatten down any protuberance in the paper. The sheets are afterwards separated from the felts, and hung up to dry five or six together. Next, they are dipped in a tub of size, which is made from skins and other animal substances,

to prevent the ink from running, as it does on blotting-paper which is paper not sized; then they are dried again; examined separately, to remove defective sheets, pressed again, finished, and put up into reams, containing 20 quires of 24 sheets each, ready for sale and use.

There are two descriptions of paper, one called wove, the other laid. The wire-cloth used for the former is woven in a loom, in the same manner as woollen cloth; the laid-paper mould is made with wires close together, and crossed at right angles by stronger wires, an inch apart, which produce the marks in the paper.

Very little paper is now made by hand in comparison with the enormous quantity made by machine. The first machine was made in France in the year 1799 by Robert, a workman in the mill of M. Didot, a celebrated printer. The government rewarded his ingenuity by a gift of 8000 francs. But the machine was very imperfect, and in the year 1802 M. Didot came to England and took out patents, and for the necessary advance of capital to perfect this invention they were assigned to Henry and Seely Fourdrinier; and subsequently, at their establishment in Bermondsey, under the superintendence of Mr. Donkin, then in their employment, and under whose aid and assistance the machine was completed, and in principle was then sent out to the trade as perfect as now, although fifty years have transpired since the first was

erected and set to work. This machine, which has superseded all others, is equally ingenious and simple. It imitates the hand-process, but effects the work more perfectly and with greater rapidity. It can make 250 square feet of paper in a minute, and, consequently, 150,000 square feet in a working day of ten hours.

The pulp is first made to flow from the vat upon a wire frame or sifter, which moves rapidly up and down, so as to force the fine filaments of the pulp through the wire, whilst it retains any knots or unsuitable matter. Having passed through the sifter, the pulp flows over a ledge in a regular and even stream, just like a stream of water over a mill-dam, and falls upon an endless web of wire-gauze twenty-five to thirty feet long, which is continually moving onward from the vat to the other end of the machine. The endless web may be compared to a jack or round towel, stretched on two rollers, one at each end, but moving horizontally instead of being hung up. The pulp falling on the surface of the endless wire, is carried forward by its motion, spread out like a napkin on a table. A shaking motion is given to the wire which assists the pulp in spreading evenly, and also facilitates the separation of the water which is drained off through the wire. The pulp is prevented from flowing over the edges by a strap, which is also used in fixing the width

of the paper. When the pulp falls on the wire it resembles milk, as it advances it becomes solid, and when it has reached the end it resembles wet blotting-paper. The paper, as it may now be called, is taken from the endless band of wire, by an endless band of woollen cloth, forming an inclined plane, and as the paper gradually moves forward, the cloth abstracts a further portion of the moisture which it still retains. It is now seized by two rollers, which press it severely, and passing from between them, travels up a second endless band of cloth, and is pressed between a second pair of rollers. The substance of the paper has now been completely made, and nothing remains to be done but to render it dry and smooth. For this purpose the paper is carried over the polished surface of a set of large rollers, heated by steam of different degrees. After this it is pressed between the cylinder and a woollen cloth, and then carried to a reel on which it is wound perfectly dry and smooth. In short, the pulp flows at one end of the machine like a stream of milk, and comes out of it at the other end in two minutes after, formed into a large sheet of paper, fit for use. It is calculated, that in this way, the machines at work in England alone make 2,160 miles of paper daily! Some manufacturers cut their paper into regular sizes by a machine connected with the one which makes it, others by a separate machine.

The thickness of the paper is regulated by the rate at which the endless band of wire gauze is moved, and the quantity of pulp which is allowed to flow upon it. For instance, suppose the wire, when moving 25 feet a minute, and with five gallons of pulp falling on it, will make a sheet of paper thick enough to weigh 100 lbs. to the ream, or 500 sheets; then, if the wire moves at the rate of 30 feet per minute, with the same quantity of stuff, the paper will not be so thick by a fifth, and will weigh only 80 lbs. to the ream. Again, let the pace of the machine be 25 feet per minute, and the quantity of pulp ten gallons, instead of five, in that case the sheets of paper will be twice as thick, or 200 lbs. to the ream.

The increase in the make of paper has more than doubled in the last twenty years, being in the year 1834 about 31,000,000 lbs., in 1852 about 68,000,000 lbs., and in the years 1853 and 1854, 79,000,000 lbs.*

It is often said, "one cannot make a silk purse out of a sow's ear," but the process of paper-making seems very like it. The ragged garment of a Hungarian shepherd, the turban of a Turk, the blue shirt of an Italian sailor, the bed-covering of a German farmer, the fine linen of a Hamburg merchant, the gabardine of an African Jew, the shreds and

* The duty on this quantity of paper was nearly half a million sterling.

patches of a London tailor, the cast-off rags of an Irish beggar, and the pickings of the dunghill, are collected together, reduced to a fluid, and converted into the leaves of a beautiful book, or the delicate note-paper used by ladies. The transformation excited the wonder of Addison, when paper-making was a much less wonderful process than it is now. "Our paper-manufacture," he writes, "takes in several mean materials, which could be put to no other use, and affords work for several hands in the collecting of them, which are incapable of any other employment. These poor retailers, whom we see so busy in every street, deliver in their respective gleanings to the merchant. The merchant carries them in loads to the paper-mill, where they pass through a fresh set of hands, and give life to another trade—and the whole nation is in a great measure supplied with a manufacture for which formerly she was obliged to her neighbours. The materials are no sooner wrought into paper, but they are distributed amongst presses, where they again set innumerable artists at work, and furnish business to another mystery. From thence, accordingly, as they are stained with news or politics, they fly through the town in postmen, post-boys, daily courants, reviews, medleys, and examiners; men, women, and children contend who shall be the first bearers of them, and get their daily subsistence by spreading them. It is pleasant enough to

consider the changes that a linen fragment undergoes by passing through the several hands above mentioned. The finest pieces of holland, when worn to tatters, assume a new whiteness more beautiful than the first, and often return in the shape of letters, to their native country. In a word, a piece of cloth, after having officiated for some years as a towel or a napkin, may, by this means, be taken from a dunghill, and become the most valuable piece of furniture in a prince's cabinet!"

Calico-Printing.

Calico-printing has been as useful in clothing the body, as letter-press printing in educating the mind. It unites most of the other processes, as, for instance, block-printing, both by hand and press, cylinder printing, and chemical printing.

The printing is effected in the first place by blocks. The design, which we will suppose for the sake of clearness, is to be printed in one colour only, is engraved on a block of sycamore wood, about a foot long and seven inches wide. Sometimes, too, the design is formed by slips of copper let into the face of the block. The printing is performed by a man and a boy or girl. A piece of calico is unrolled, and stretched on a table, at one end of which is a trough containing the colour in which the design is to be printed, and a sort of elastic cushion formed like a circular

trough. The boy, dipping a brush in the pot, smears the colour on the cushion; the man transfers the colour to the engraved block by pressing the block on the cushion; and then pressing the block on the calico, it is printed. This process is repeated until the whole length of the calico is printed. If the design is to be printed in more than one colour, then more than one block is used. Every colour requires a separate block. Suppose, for instance, the design is to be printed in three colours, red, blue, and yellow; the printer takes the block for the red colour, and stamps it on every part of the cloth which is to be printed red. Then he takes the block for the blue colour, and works all over the cloth again wherever it is to be printed blue. Then he repeats the process for the yellow part of the design. But how, it may be asked, does he contrive to adjust each successive impression, so that all shall fall in their right places, and not be confused one with the other? This requires considerable dexterity, and is one of the niceties of block-printing. Small pins are placed at the corners of the blocks, by the aid of which the impressions are made correctly; and besides it is so contrived that the raised part of one block shall fall in the stamping exactly where there were depressions in the other blocks; or, in other words, the block touches only those parts of the cloth which have not been printed,

and being hollowed out, arches over those parts which have been printed.

This is a very slow and defective mode of printing. The block must be coloured and stamped 448 separate and distinct times for each colour in printing one piece of cloth; and besides it is almost impossible to avoid irregularities in the design. Block-printing has, therefore, being nearly superseded by machinery, which not only prints faster, but better, and at a smaller cost. One of the inventions is called the Perrotine. The cloth to be printed is wound round a prismatic or four-sided roller, and three engraved blocks are made by springs, to dip themselves in troughs of different colours, and press one after another on three faces of the roller, as it is turned round either by hand or steam. The printing is done beautifully, and with so much rapidity that one man and three children will print thirty pieces of calico a-day, or as much as twenty men and twenty children can print with blocks. Another invention consists of a press, greatly resembling the common printing press, by which the colours are printed, not in succession, but all at once. The mode is too complex to be described here. The chief invention in calico-printing is the cylinder machine. In this, the sidereographic process, already described in a preceding page, is used. A design is engraved on a small roller called a *dye*, this is hardened and made to give an

impression on another roller called a *mill*. As the design is cut *into* the face of the first roller, or engraved, in the second, it is, of course, raised, or in relief. The mill is now rolled upon a third roller, to which the design is thus transferred; this third roller is used for printing. The printing roller is turned round by hand or steam, and in turning the lower part of it dips in a trough containing the colouring matter which is to be used. The colouring matter, of course, becomes spread over the whole surface of the roller, as every part of it dips in the colouring matter as it revolves, and, therefore, the printing would be a mere daub, if the roller were not cleaned. This is effected by the edge of a piece of brass resembling a knife, which scrapes off every particle of the colour, except that which has sunk into the lines of the engraving.* The cloth descends from a roller

* This important appendage to the machine is called the "doctor," a name which has been thus oddly accounted for in Lancashire: when one of the partners in the firm by whom cylinder printing was originally applied was making experiments on it, one of the workmen, who stood by, said, "Ah! this is very well, sir, but how will you remove the superfluous colour from the surface of the cylinder?" The master took up a common knife which was near, and placing it horizontally against the revolving cylinder, at once showed its action in removing the colour, asking the workman, "What do you say to this?" After a little pause, the man said, "Ah, sir, you've *doctored* it," thus giving birth to a name for the piece of apparatus. Others would derive the name from *ductor* or *conductor*.—*Dod's Textile Manufactures.* One of the

on which it is wound at the top of the machine, is pressed against the printing roller by another roller, touches the engraved part, imbibes the colour, and in this way is printed. The cloth continues to descend, the roller continues to revolve, so that there is no pause in the printing until the whole length of cloth is printed. When the design is to be printed in more than one colour more than one printing roller is used. Some of these machines will print a piece of calico of 28 yards in a minute, which is at the rate of a mile an hour. Indeed, some of the mills in Lancashire print every year calico of a sufficient length to girdle the earth!

Paper-hangings are printed in a similar manner to calico. But there is this difference, that while machine-printed calico is the best, block-printed paper is the best. The colours of machine-printed paper-hangings rub out quickly, and, therefore, block-printing is still practised very extensively.

inking-rollers of the common printing machine is also called the "doctor;" a term which is clearly a corruption of ductor, as the roller conducts the ink from the reservoir to the type.

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